DEVONIAN CONODONT BIOSTRATIGRAPHY IN THE SUBSURFACE OF MASON COUNTY, WEST VIRGINIA

Thesis

Submitted To The Graduate School

West Virginia University

In Partial Fulfillment Of The Requirements For

The Degree Of Master Of Science

by

George Roy Clarkson, B.S.

Morgantown

West Virginia

June, 1980

DEVONIAN CONODONT BIOSTRATIGRAPHY IN THE SUBSURFACE OF MASON COUNTY, WEST VIRGINIA

Thesis

Submitted To The Graduate School

West Virginia University

In Partial Fulfillment Of The Requirements For

The Degree Of Master Of Science

By

George Roy Clarkson, B.S.

Morgantown

West Virginia

June, 1980

CONTENTS

ABSTRACT

Conodonts were extracted from eighty-one samples taken from the Onondaga Limestone (Eifelian) through Middle and Upper Devonian shales (Frasnian and Famennian) in a core from Mason County, West Virginia. Fifty-five non-ramiform conodont taxa were identified, including _Scaphignathus velifer_ which has not previously been reported from North America. Conodonts indicate that the Onondaga Limestone ranges in age from the _Polygnathus costatus patulus_-Zone to the _P. c. costatus_-Zone. The overlying shale samples range in age from probable Middle Devonian (Eifelian) to the _Scaphignathus velifer_-Zone (Famennian). Statistical and visual comparisons of conodont occurrences with elemental and mineralogic data showed no discernible relationships.

ACKNOWLEDGEMENTS

The author acknowledges the support of this research by the West Virginia Geological and Economic Survey and its Director, Dr. Robert Erwin (under contract DC-AC21-76MC05199 with the U. S. Department of Energy/Eastern Gas Shales Project). Special thanks are due to both Professor Roy B. Clarkson and the Biology Department, West Virginia University, for use of laboratory space and research facilities. Without the use of those facilities this study would have been severely hampered. Special thanks is also due Sarah C. Smith without whose encouragement this study would not likely have been completed. The author also appreciates the assistance of the thesis committee, and especially, Dr. Steven M. Warshauer for advice and encouragement. Robert Vinopal gave freely of a great amount of his time to take the SEM photographs used in this paper. Appreciation is also due to Dr. J. Renton, C. A. Nicholson, Joan Wright, Pam Stalnaker and Joe Kposawa of the West Virginia Geological and Economic Survey, Analytical Section for running the geochemical analyses. Dr. Joseph Schwietering is thanked for providing information on Devonian Shale stratigraphy. The author thanks Paul Queen for the drafting.

This document was produced using SCRIPT under CMS at

WVNET. Range charts were produced at WVNET using programs written by the author.

PRELIMINARY
OPEN-FILE REPORT
SUBJECT TO REVISION

INTRODUCTION

Conodonts are tooth-like microfossils composed of concentric lamellae of calcium phosphate and exhibit a great variety of gross external morphologies.

C. H. Pander discovered conodonts in 1856 and thought them to be fish teeth. Since then, a great variety of diverse ideas have been put forward to describe the biologic nature of conodonts (see Lindstrom, 1973). Much of this evidence has lent support to the idea that conodonts are actually the internal skeletal elements of some type of extinct organism and that this organism was composed of several conodont element form-taxa arranged in a bilaterally symmetrical pattern.

Natural assemblages (found on bedding planes) and statistical assemblages (reconstructed from disaggregated residues) of conodont element form-taxa have been defined and multi-element reconstructions of the supposed conodont animal have been made. Assemblages and multi-element reconstructions are described by Rhodes (1952), Lange (1968), Klapper and Philip (1971), and other workers.

Detailed work, particularly in Europe and North America, on conodont biostratigraphy has resulted in the definition of many conodont zones that can be recognized over large geographic areas and in many different lithclogies. Three characteristics of conodonts permit this: 1) because conodonts evolved rapidly, many form-taxa have very restricted temporal distribution, 2) newly evolved taxa were distributed rapidly cver large geographic areas, and 3) conodonts exhibit a relatively high degree of facies independence although several studies (summarized in Barnes, 1976) show that conodonts are facies-controlled to scme degree.

These characteristics ccmbine to make conodonts very useful and well-studied Paleozoic index fossils. Conodont biostratigraphy is particularly well defined for the Upper Devonian of Europe and North America. The numerous zones and subzones make very accurate correlations possible. This is useful for precise time-stratigraphic correlations in rocks that lack well-defined lithologic time lines.

The purpose of this study is to establish the conodont zonation present in shales overlying the Onondaga Limestone (Middle Devonian) in a core from Mason County, West Virginia. The core was taken from Reel Drilling Program well D&K Farms #3 (W. Va. Permit MAS-146; DOE/EGSP core 41), 8.06km (5.00 mi) south of Latitide 3900 N. and 5.15km (3.19 mi) west of Longitude 8200' W. (UTM coordinates, 408187.2 meters east, 4308929.0 meters north, zone 17), Robinson District, Mason County, West Virginia (fig. 1). Dating cf these shales with respect to the well-defined Late Devcnian conodont zonation is important because shales of the upper 15.2m (50 ft) and lower 3.4m (11 ft) of the cored interval lack distinctive marker beds that would permit accurate correlations based on gamma-ray and neutron logs. Establishing the zonation present in the core will also aid in basin-wide correlation of the shales; this correlation is an important part of the Department of Energy sponsored Eastern Gas Shales Project (EGSP).

The secondary purpose of this thesis concerns the paleoecology of the conodonts in the core. It is hoped that paleoenvironments at the time of deposition of the shales are reflected by the present geochemistry of the shales. If this is the case, conodont occurrence might be influenced by the distribution of various geochemical parameters in the shales; such relationships will be sought and, if found, may be interpretable in terms of the paleoecology of the conodonts.

METHOD

Sample collection

Eighty-one 1-kilogram (2.2 pound) samples were taken from 816.7m (2679.5 ft) to 1037.9m (3405.3 ft) below the top of the well (well elevation 202.7m (665 ft) KB) at approximately 10 foot intervals. All depths used in the text are corrected log depths, not drillers' or core depths. Centers of sampling intervals are shown on Plate 1 and Figure 4; the actual intervals extend 0.06m (0.2 ft) above and below the plotted tic marks. For reasons concerning the geochemical analyses, each sample was taken in only one lithology and rock color (determined by visual inspection) whenever possible. The bottom four samples were obtained from the Onondaga Limestone in the lowermost 1.3 m (4 ft) of the core.

Paleontological sample preparation

Onondaga Limestone samples were processed using standard acetic acid techniques. Shale samples were disaggregated using a two-step bleaching and boiling process (Duffield and Warshauer, 1979). Conodonts were recovered from most samples by heavy liquid seperation in s-Tetrabrcmoethane.

Geochemical sample preparation

Following initial physical breakdown of each sample for paleontologic analysis, approximately 0.1 kg of rock chips was selected for geochemical studies. These were crushed to finer that 200-mesh in a Prolabo ball-crushing mill. The short (two-minute) crushing time in this mill prevented sample heating, which could cause dehydration of hydrated minerals. Geochemical analyses were done using standard procedures. Determination of elemental composition of the samples was done using X-ray flourescence. Mineralogic composition was determined by X-ray diffraction. Percent crganic content of each sample was determined by loss-on-ignition at 550 degrees Celsius.

LITHOSTRATIGRAPHY

Lithology

The Mason County core was described by Rhoades and others (1978, unpublished manuscript). The cored interval consists of olive-gray shales alternating with medium- and dark-gray shales.

Four petrologic rock types have been described in the core (Ervin, 1980). The four shale types are: 1) thinly-laminated; 2) sharply-banded; 3) lenticularly-laminated; 4) non-banded. Siltstones and concretions are also present in the core.

Stratigraphy

Figure 2 shows Middle and Upper Devonian stratigraphy in West Virginia, Ohio and New York.

<u>Onondaga Limestone</u>-The Onondaga Limestone marks the base of the Middle Devonian in West Virginia and New York. The Onondaga grades into the Needmore Shale and the Huntersville chert to the east. To the west, the Columbus Limestone of Ohio has been correlated with the Onondaga.

At the top of the Onondaga Limestone in Mason County is a thin (0.06m (0.19ft)), dark, pyritic layer that contains abundant paleoniscid fish teeth (D. K. Elliot, 1980, personal communication) and conodonts. Both the lower contact and the upper contact (with the Devonian

Shales) are sharp. The extreme abundance of conodonts, fish teeth and euhedral pyrite suggest that this unit was deposited over a considerable period of time. Wells (1944) suggests that the Middle Devonian bone beds of Ohio are diastemic in origin and may even be lag deposits resulting from submarine erosion. However, the excellent preservation of the conodonts and teeth does not support the lag deposit theory of origin for this bone bed because the winnowing currents would probably have broken and abraded the conodonts and teeth.

<u>Devonian</u> <u>Shales</u>-In the subsurface of western West Virginia the term "Devonian Shales" or "Brown Shales" refers to the shale sequence between the Onondaga Limestone and the Lower Mississippian Berea Sandstone (Patchen, 1977). Figure 3 shows the lithostratigraphic terminology of the cored interval based on gamma-ray and neutron logs (Schwietering, 1979, personal communication).

In Figure 3, New York stratigraphic terminology is used for the stratigraphic units. This is because stratigraphic cross sections within the Devonian Shales by Wallace and others (1977, 1978) and West (1978) show that the stratigraphic units present in New York can be traced, in the subsurface, through Pennsylvania and into West Virginia and Ohio. In general, the New York terminology permits a higher degree of division and refinement of the stratigraphic section than does the West Virginia terminology and probably has priority over the West Virginia terminology. Therefore, the New York terminology is preferred, where appropriate. Regional correlation by Schwietering (unpublished charts) show that the Mason County well fits into the stratigraphic framework established by Wallace and others, and West. Therefore, New York terminology is appropriate for stratigraphic intervals in this core.

The term "Huron Member of the Ohio Shale" is shown to be applicable to western West Virginia by Schwietering (1979).

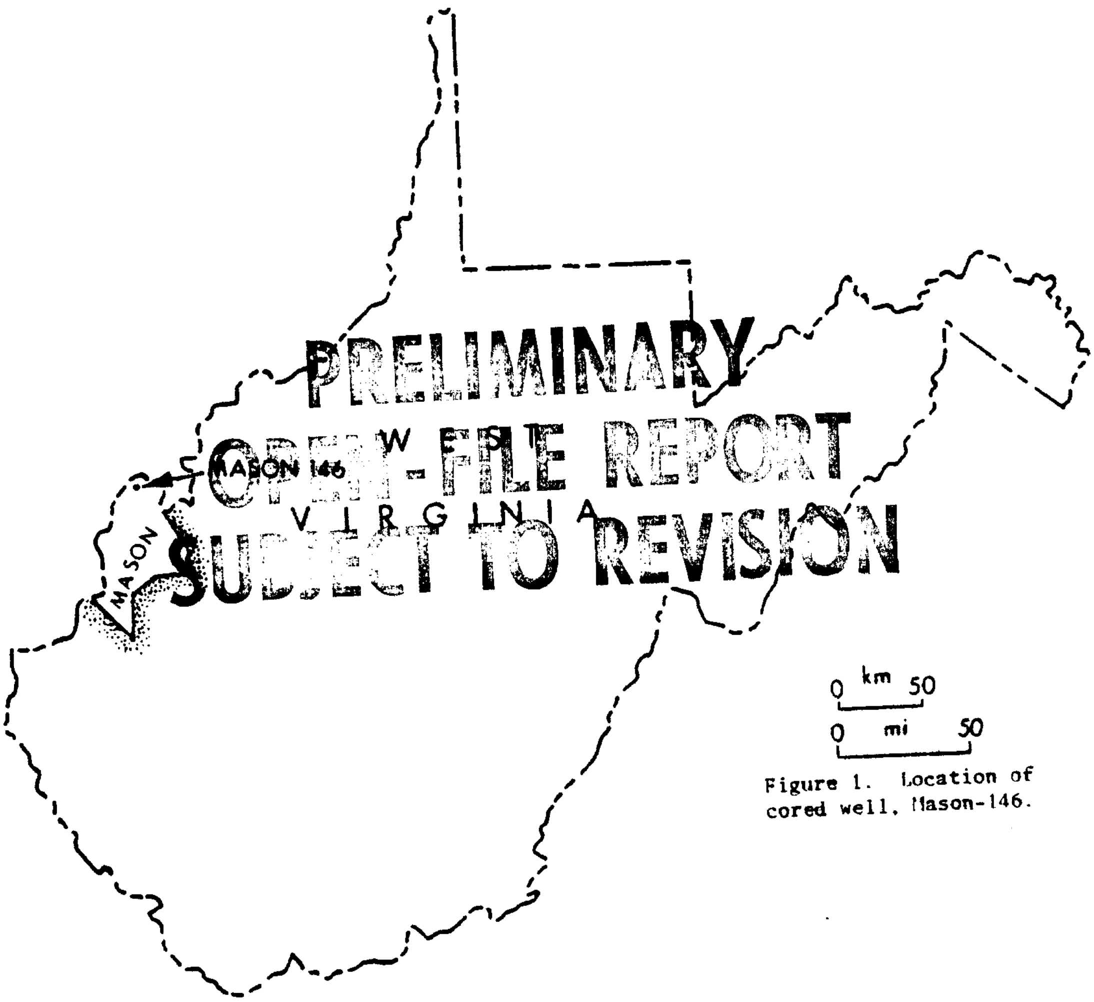


Figure 1. Location of cored well, Mason-146.

OHIO	VIRGINIA	PENNSYLVANIA / WEST VIRGINIA	NEW YORK		
BEREA SANDSTONE BEDFORD SHALE	POCONO FORMATION	POCONO FORMATION		MISSISSIPPIAN	
OHIO SHALE: CLEVELAND MEMBER	HAMPSHIRE FORMATION	HAMPSHIRE FORMATION	CONEWANGO GROUP	DEVONIAN	UPPER
OHIO SHALE: CHAGRIN SHALE	CHEMUNG FORMATION	CHEMUNG FORMATION	CONNEAUT GROUP		
OHIO SHALE: HURON MEMBER			CANADAWAY GROUP		
UPPER OLENTANGY SHALE	BRALLIER FORMATION	BRALLIER FORMATION	JAVA FORMATION		
			WEST FALLS FORMATION		
			SONYEA FORMATION		
	MILLBORO SHALE	HARRELL SHALE	GENESEE FORMATION		
LOWER OLENTANGY SHALE		TULLY LIMESTONE	TULLY LIMESTONE		MIDDLE
		MAHANTANGO FORMATION	MOSCOW FORMATION		
			LUDLOWVILLE FORMATION		
			SKANEATELES FORMATION		
DELAWARE LIMESTONE		MARCELLUS SHALE	MARCELLUS SHALE		
COLUMBUS LIMESTONE	ONONDAGA LIMESTONE / HUNTERSVILLE CHERT / NEEDMORE SHALE /	ONONDAGA LIMESTONE / HUNTERSVILLE CHERT / NEEDMORE SHALE /	ONONDAGA LIMESTONE		

FIGURE 2. STRATIGRAPHIC NOMENCLATURE FOR MIDDLE AND UPPER DEVONIAN ROCKS IN THE APPALACHIAN BASIN

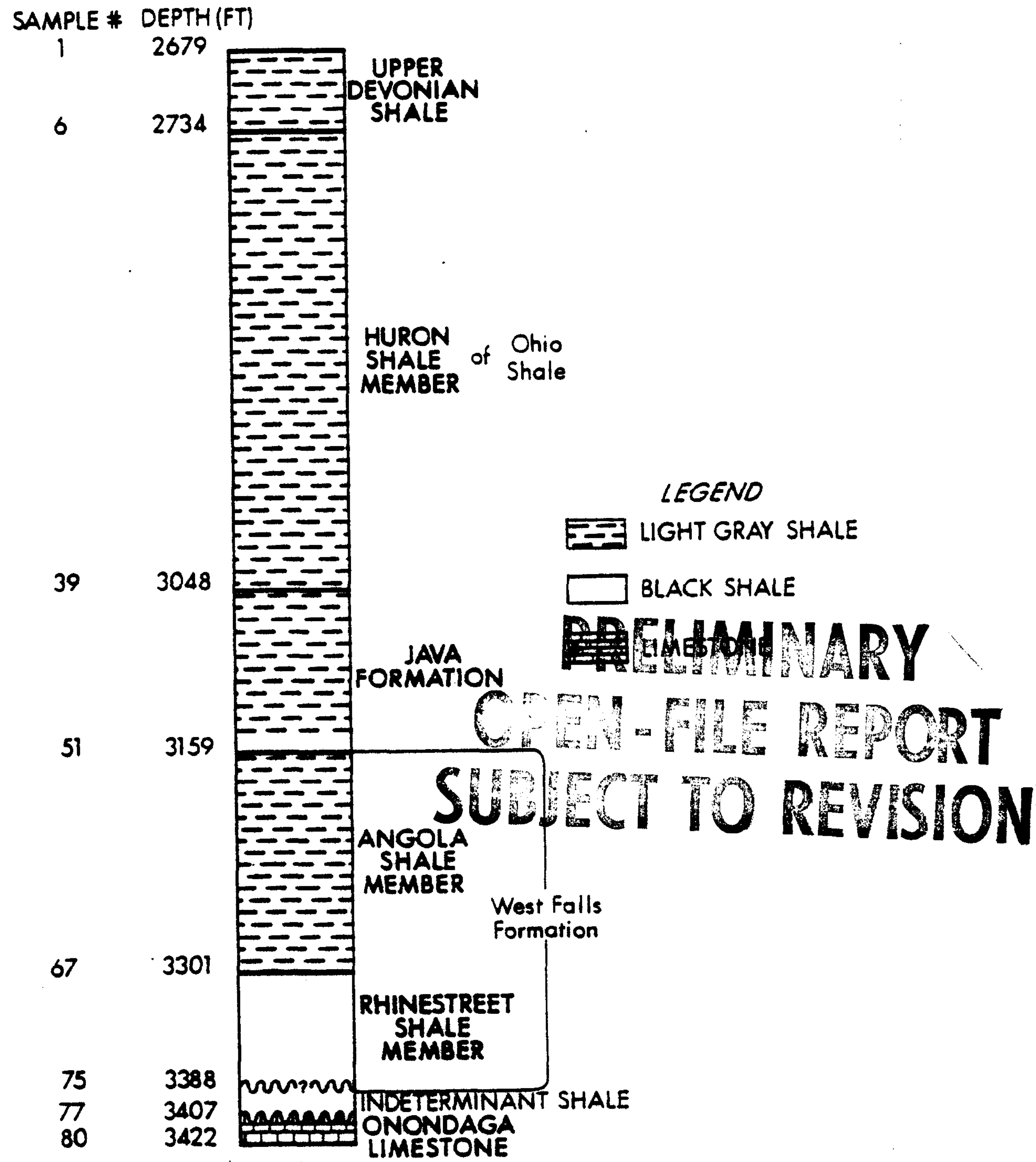


Figure 3. Lithostratigraphy of cored well Mason-146.

DEVONIAN CONODONT BIOSTRATIGRAPHY

Previous investigations

Ziegler (1971) summarized the Devonian Conodont zonation observed in Europe. Klapper and others (1971) correlated North American conodont occurrences with Ziegler's zonation.

In the Lower and Middle Devonian, conodont taxa were mostly endemic. However, by Upper Devonian times, a great many conodont taxa exhibit cosmopolitan distribution. The change from endemism to cosmopolitanism has been explained by Klapper and Johnson (1980) as being caused by the changing arrangement of continental plates, eustatic sealevel changes and associated changes in oceanic circulation patterns, from Lower-Middle Devonian times to Upper Devonian times.

Thus, different Lower and Middle Devonian conodont zonations exist for various paleogeographic provinces while, in the Upper Devonian, most conodont zones can be recognized over areas of great geographic extent. The Upper Devonian conodont zonation established by Ziegler has remained relatively unchanged except for minor changes by Ziegler and others (1976) and the addition of a new zone (the Lower <u>rhomboidea</u>-Zone) by Sandberg and Ziegler (1973).

The Upper Devonian zonation has been successfully applied outside Europe in Australia (Glenister and Klapper, 1966), in North America (Winder, 1966; Clark and Ethington, 1967; Schumacher, 1972) and in West Virginia by Duffield, 1978; Duffield and Warshauer, in press).

The only published study of a Devonian conodont zonation in West Virginia is that of Duffield and Warshauer (in press) who studied the zonation present in a core taken in Lincoln County, West Virginia (located about 100km (62mi) southeast of this core). They studied conodonts from the Onondaga Limestone and approximately 121.9m (400 ft) of shales overlying the Onondaga. The Onondaga Limestone was given an age assignment of lowermost Middle Devonian (Lower Eifelian). The shales were found to range in age from the middle Frasnian (Polygnathus assymmetricus-Zone) to uppermost Frasnian (Lower Palmatolepis triangularis-Zone).

Several studies of Devonian conodonts in Ohio have been conducted. Stewart and Sweet (1956) described conodonts of the Middle Devonian bone beds of Ohio and correlated the Columbus Limestone with the Onondaga Limestone. Other studies of Devonian strata in Ohio have included the Columbus and Delaware Limestones (Ramsey, 1969) and the Olentangy Shale (Ramsey, 1969; Gable, 1973). Neither Ramsey nor Gable were able to correlate conodonts of the Lower Olentangy Shale with those of the

European zonation. However, Gable was able to tentatively assign a Late Devonian age to the Upper Olentangy Shale. On the basis of ostracodes, Tillman (1969) also assigned a Late Devonian age to the Upper Olentangy Shale.

Studies of Upper Devonian conodonts in New York have been successful in correlating New York conodont sequences with those observed in Europe. These studies are summarized by Rickard (1975). A brief summary of the Devonian conodont zonation pertinent to this study is given below (from Rickard, 1975). The West Falls formation contains the upper part of the *Polygnathus asymmetricus*-Zone, the *Ancryognathus triangularis*-Zone and the *Palmatolepis gigas*-Zone. The Java formation contains part of the *Palmatclepis triangularis*-Zone. The Ohio Shale (Canadaway, Conneaut and Conewango Groups of New York) contains the *Palmatolepis crepida*-Zone, the *P. rhomboidea*-Zone, the *P. marginifera*-Zone and the *Scaphignathus velifer*-Zone.

Conodont zonation in the Mason County core

Conodonts from the lowest sample in the Onondaga Limestone indicate an age of upper Lower Devonian or lower Middle Devonian based on the occurrence of *Polygnathus costatus patulus*. The remainder of the Onondaga is assigned an age of lower Middle Devonian based on the occurrences of *Icriodus corniger* and *Polygnathus costatus*

costatus.

Conodonts from the bone bed at the top of the Onondaga (_Icriodus corniger_, _Polygnathus costatus costatus_) are diagnostic of the Middle Devonian (Lower Eifelian).

Questionable interval at base of shale sequence.--The lower 6.8m (21 ft) of the shale section of the core could not be correlated with other Devonian Shale wells by the use of geophysical logs. Two samples were taken in this interval. No conodonts were recovered from the upper sample (1036.3m (3389.7 ft)). However, several specimens of _Polygnathus linguiformis linguiformis_ gamma morphotype were recovered from the lower sample (1036.3m (3400.0 ft)). Unfortunately, the gamma morphotype of _P. l. linguiformis_ ranges from the early Middle Devonian through the early Upper Devonian (Ziegler, 1977, p. 466) so a specific age determination for this sample is not possible. However, it is apparent that at least the early Upper Devonian (and possibly including part of the Middle Devonian) is represented by only 3.0m (10 ft) of rock in this core. This suggests that either a signifigant portion of the stratigraphic section has been removed by erosion or that one or more diastems are present, or both. Schwietering (1980, personal communication), on the basis of intra-basinal stratigraphy, prefers assignment of this interval to the

Middle Devonian Hamilton Group. The conodont biostratigraphy does not deny this interpretation.

Devonian Shale interval.-- Stratigraphically important conodont taxa indicate that the upper seventy-five samples (from depth 1030.1m (3379.7 ft) to depth 816.7m (2679.5 ft)) range in age from the _Polygnathus asymmetricus_- or _Ancryognathus triangularis_- Zones to the _Scaphignathus velifer_-Zone, (Figure 4).

Polygnathus asymmetricus or Ancryognathus triangularis Zones.-- Samples 75 to 67 are placed within the _Polygnathus asymmetricus_ and _Ancryognathus triangularis_ zones based on the occurrence of _Palmatolepis proversa_, _Ancryodella curvata_ and _A. lobata_. The absence of _Polygnathus asymmetricus_ prevented delineation of the boundary between the two zones.

Palmatolepis gigas-Zone.-- This zone is recognized between samples 66 and 39, inclusive. The base is delineated by the first occurrence of _P. gigas_. The top is indicated by the last occurrence of _Ancryognathus asymmetricus_.

Palmatolepis triangularis-Zone.-- This zone is recognized at sample 38 and is based on the occurrence of _Palmatclepis triangularis_.

Palmatolepis crepida-Zone.- This zone is recognized in samples 38 and 37 and is indicated by the first occurrences of _Palmatoleris quadrantinodosalobata_ and

Polygnathus glaber glaber. Sample 38 contains taxa characteristic of both the crepida-Zone and the triangularis-Zone. Either the triangularis-Zone is extremely thin or sample 38 is located on the boundary between the two zones. This thinning could be caused by the presence of a previously unrecognized diastem at this stratigraphic position. Alternatively, it is possible that the thinness of these two zones may be caused by tectonism. Evans(1979) noted the presence of northwest-oriented slickensides at the base of the Huron Shale Member in the Mason County core and in several other Devonian Shale cored wells. [illegible] over a large area in western West Virginia and northern Kentucky and may be related to the flying out of detachments to the east, (Evans, 1979). It is possible that sufficient movement has occurred within this interval to cause tectonic thinning of the twc conodont zones.

Palmatolepis rhomboidea-Zone.-- This zone is recognized between samples 37 and 18, inclusively. the base of the zone is indicated by the first occurrence of Polygnathus glaber glaber. The top of the zone is indicated by the first occurrence of Palmatolepis marginifera marginifera, P. quadrantinodosa quadrantinodosa and P. q. inflexa. Palmatolepis rhomboidea occurs only in sample 21.

Palmatolepis marginifera marginifera-Zone.-- This zone is recognized between samples 17 and 2, inclusively. The base of the zone is indicated by the first occurrence of *P. marginifera marginifera*, *Palmatolepis quadrantinodosa quadrantinodosa* and *P. q. inflexa*. The top of the zone is indicated by the first occurrence of *Scaphignathus velifer*.

Scaphignathus velifer-Zone.--The top sample of the core, 816.7m (2679.5 ft) contains two specimens of the genus *Scaphignathus*. It is tentatively assigned to *S. velifer* for reasons discussed under SYSTEMATIC PALEONTOLOGY. However, regardless of the solution to the taxonomy problem, this sample can still be placed in a distinct zone on the basis of the generic assignment.

Comparison to the New York Section

The conodont zonation established for the Mason County core is comparable with that established for the New York Devonian. Conodont zones generally occur within the same lithostratigraphic units in Mason County as they do in New York. Similarities and differences are discussed below based on Rickard, (1975) and this study.

The *velifer*-Zone does not occur in New York. However, in New York, faunas with *S. subserratus* and *Polygnathus inclinatus* are time-equivalent to the Upper *velifer*-Zone and occur above the facies equivalents of the Huron Shale Member in New York. The *velifer*-Zone occurs above the Huron Shale Member in the Mason County core.

The *marginifera*-Zone and the *rhomboidea*-Zone occur within the Huron Shale Member in the Mason County core. They occur within facies equivalents of the Huron Shale in New York.

The *P.* *triangularis*-Zcne occurs within the facies equivalents of the Huron Shale in New York. This zone occurs at the base of the Huron Shale in Mason County.

The *crepida*-Zone occurs within the Java Formation in New York but it occurs at the base of the Huron Shale Member in the Mason County ccre. This discrepancy may be due to the diastemic or tectcnic thinning of the *triangularis*-Zone and the *crepida*-Zone in the Mason County core.

The *gigas*-Zone occurs within the Angola Shale Member in New York. In the Mason County core the *gigas*-zone occurs within both the Java Formation and the Angola Shale Member.

The *A.* *triangularis*-Zcne and the *asymmetricus*-Zone occur within the Rhinestreet Shale Member in New York as they do in the Mason County core.

The Onondaga Limestone contains faunas with *P.* *costatus* *patulus* in New York and in the Mason County core.

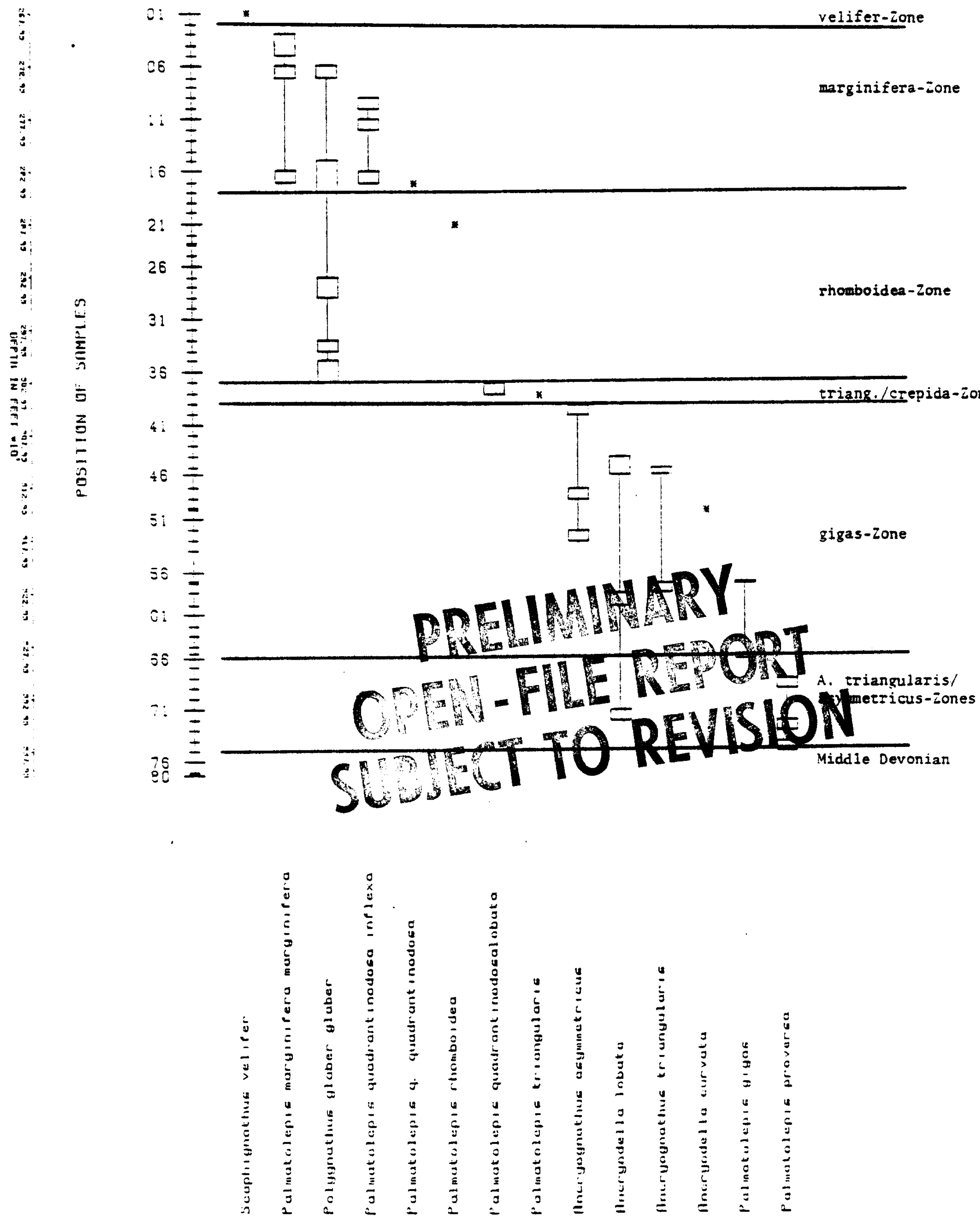


FIGURE 4. RANGE CHART OF BIOSTRATIGRAPHICALLY IMPORTANT CONODONTS (MASON COUNTY-146)

ANALYSIS OF GEOCHEMICAL DATA

Geochemical data and non-ramiform conodont presence/absence data were analyzed visually and statistically in hopes of finding relationships between conodont occurrence and geochemical values that could be interpreted in terms of conodont paleoecology. No relationships were found.

Initially, the presence/absence of each conodont taxon was visually compared to strip plots of abundances of thirteen elements and nine minerals in the shale samples. Plots of simple diversity of conodont elements were compared to the geochemical data. Rock color and organic content were also compared to the conodont data. No visual relationships were discernible.

Cluster analysis, multidimensional scaling and factor analysis were performed on R-mode standardized data sets of conodont occurrence and mineralogic data and conodont occurrence and elemental data. Once again, no relationships were observed. Cophenetic correlations from cluster analysis were extremely poor for both data sets (0.663 and 0.661) and stress in the multidimensional scaling plots was 0.99 for both datasets. Eigenvalues of the first three factors extracted from the datasets by factor analysis (Table 1) are extremely low.

Correlation matrices of conodont data with mineralogic data showed very low correlations in most cases. A few relatively high correlations(0.6) were found but these usually involved single conodonts found in single samples and are probably fortuitous.

	FACTOR 1	FACTOR 2	FACTOR 3
ELEMENTS	5.422	4.001	3.741
MINERALS	5.432	4.999	3.758

Table 1. Eigenvalues from factor analysis.

The lack of detectable relationships between conodont occurrences and geochemical parameters could be caused by several factors:

1) The geochemical data may not reflect environmental conditions at the time of deposition but may have been influenced by diagenesis.

2) The conodonts may actually have been in no way affected by the measured geochemical parameters. The conodonts may not have responded to the conditions of turbidity(indicated by the detrital

minerals: quartz, plagioclase, orthoclase, illite and kaolinite) present during the deposition of these shales. In addition, the conodonts may not have been effected by the conditions of oxidation-reduction present during deposition (as indicated by high sulfur content. High sulfur content correlates with high organic content which usually indicates a reducing environment.). Possible environmental conditions indicated by other minerals and elements are problematic and do not appear to effect conodont distribution in this core.

3) Recovery of conodonts from the shales may have been insufficient to permit detection of relationships. Normally, less than twenty percent of each sample disaggregated and released conodonts. If disaggregation had been total, relationships might have been observed.

FAUNA OF THE MASON COUNTY CORE

Conodonts

Forty-eight form-species of non-ramiform conodont elements were identified in the Mason County core. Ramiform conodont elements were not identified but were present in almost every sample. Conodont "pearls" (A. G. Harris, 1980, personal communication) were found in several samples. The non-ramiform-conodont form taxa consisted of:

<u>Ancryodella</u> <u>curvata</u> (Branson & Mehl, 1934)

<u>Ancryodella</u> <u>lobata</u> Branson & Mehl, 1934

<u>Ancryodella</u> sp.

<u>Ancryognathus</u> <u>asymmetricus</u> (Ulrich & Bassler, 1926)

<u>Ancryognathus</u> cf. <u>bifurcata</u> (Ulrich & Bassler, 1926)

<u>Ancryognathus</u> <u>sinelamina</u> (Branson & Mehl, 1934)

<u>Ancryognathus</u> sp. A

<u>Ancryognathus</u> sp. B

<u>Ancryognathus</u> <u>triangularis</u> Youngquist, 1957

Genus indet. A

<u>Icriodus</u> <u>corniger</u> Wittekindt, 1966

<u>Icriodus</u> <u>cornutus</u> Sannemann, 1955

<u>Icriodus</u> <u>symmetricus</u> Branson & Mehl, 1934

<u>Ozarkodina</u> <u>immersa</u> (Hinde, 1879)

<u>Ozarkodina</u> sp. indet

Ozarkodina sp. A

Palmatolepis gigas Miller & Youngquist, 1947

Palmatolepis glabra acuta Helms, 1963

Palmatolepis glabra distorta Branson & Mehl, 1934

Palmatolepis glabra lepta Ziegler & Huddle, 1969

Palmatolepis glabra pectinata Ziegler, 1962

Palmatolepis glabra prima Ziegler & Huddle, 1969

Palmatolepis glabra sp.

Palmatolepis marginifera marginifera Helms, 1959

Palmatolepis minuta minuta Branson & Mehl, 1934

Palmatolepis perlobata grossi Ziegler, 1960

Palmatolepis perlobata schindewolfi Muller, 1956

Palmatolepis proversa Ziegler, 1958

Palmatolepis quadrantinodosa inflexa Muller, 1956

Palmatolepis quadrantinodosa quadrantinodosa Branson & Mehl, 1934

Palmatolepis quadrantinodosalobata Sannemann, 1955

Palmatolepis cf. *regularis* Cooper, 1931

Palmatolepis rhomboidea Sannemann, 1955

Palmatolepis subperlobata Branson & Mehl, 1934

Palmatolepis cf. *triangularis* Sannemann, 1955

Polygnathus bicavata Ziegler, 1962

Polygnathus cf. *glaber* Ulrich & Bassler, 1926

Polygnathus costatus costatus Klapper, 1971

Polygnathus costatus patulus Klapper, 1971

Polygnathus decorosus Stauffer, 1938

Polygnathus glaber glaber Ulrich & Bassler, 1926

Polygnathus linguiformis linguiformis Hinde, 1874, gamma morphotype, Bultynck, 1970

Polygnathus nodocostatus Branson & Mehl, 1934

Polygnathus sp. indet

Polygnathus sp. A

Polygnathus webbi Stauffer, 1938

Polylophodonta aff. *confluens* (Ulrich & Bassler, 1926)

Scaphignathus velifer Helms, 1959

Other Fauna

Foraminifera were commonly found in the Mason County core. Other, more rare fossils included: ostracodes, gastropods, pelecypods, brachiopods, *Styliolina* sp. and tentaculinids.

SUMMARY AND CONCLUSIONS

Conodont biostratigraphy indicates an age of lowermost Middle Devonian (Lower Eifelian) for the Onondaga Limestone. This is based on the occurrence of *Polygnathus contatus costatus* and *P. c. patulus*.

The 3.0m (10 ft) of dark shales overlying the Onondaga Limestone could not be assigned a definite age based on conodonts. However, the occurrence of the gamma morphotype of *Polygnathus linguiformis linguiformis* indicates that these shales are probably of Middle Devonian age. This agrees with intrabasinal correlations using geophysical logs.

The overlying Devonian shale section was found to be Late Devonian in age (ranging from Frasnian to Fammenian). The base of the shale lies somewhere within the *Polygnathus asymmetricus*-Zone or within the *Ancryognathus triangularis*-Zone. The remainder of the shales decrease in age up the core so that the *Scaphignathus velifer*-Zone is found at the top of the cored interval. The *Palmatolepis triangularis*-Zone was found to be anomalously thin possibly indicating the presence of a diastem.

Visual and statistical analysis of conodont occurrence data and elemental and mineralogic geochemistry parameters failed to show any relationships.

CLASSIFICATION OF CONODONTS

The traditional approach to conodont taxonomy has been to consider each conodont element as a separate taxon. This has resulted in the establishment of numercus form-taxa. However, as demonstrated by Schmidt (1934), Scott (1934), Rhoades (1952), Walliser (1964), Lange (1968), Jeppeson (1971), Klapper & Phillip (1971), van den Boogaard & Kuhry (1979) and many others, conodonts, in the biologic sense, were actually composed of elements of several form-taxa.

Jeppeson (1971) and Klapper & Phillip (1971) point out that form-taxonomy obscures biologic homologies and relationships and should be abandoned. However, in this paper form-taxonomic names are used for non-ramiform conodont elements. This is necessary because apparatus reconstructions have not been attempted for reasons given below. It should be understood that the taxa described under SYSTEMATIC PALEONTOLOGY are only elements of multi-element apparatuses and that form-taxonomic names are used out of necessity.

Many conodont workers have proposed

nomenclatural systems for disjunct conodont apparatus elements. Currently, the most popular system is probably that proposed by Klapper & Phillip (1971). In their system, elements are designated by letters derived either from gross morphologic characters (such as "S" for simple cone or "P" for platform) or from a generc or specific name (such as "O" for ozarkodinan). Note that in the latter case, "O" elements need not belong to the form-genus "<u>Ozarkodina</u>" but instead express morphologic homologues to "<u>Ozarkodina</u>".

Cone-shaped elements comprise the S1 and S2 elements of Klapper and Phillip's (1971) Type 4 apparatus. "<u>Icriodus</u>" completes this apparatus (Although recent evidence disputes this; see van den Boogaard & Kuhry, 1979).

Ramiform elements occur in conjunction with platform elements in the conodont animal. Many apparatuses composed of a platform "P" element (spathognathodan, polygnathan or palmatolepan), an "O" element (ozarkodinan, nothognathellan, tripodellan), an "N" element (synpriodinan, neoprioniodontan) and a symmetry transition series, A1-A2-A3 or B1-B2-B3, composed of various asymmetrical-symmetrical-asymmetrical ramiform elements. These belong to Klapper and Phillip's

(1971) apparatus Types 1,2 and 3 and van den Boogaard & Kuhry's (1979) Palmatolepis apparatuses.

In this paper, ramiform and cone-shaped elements are not assigned Linnean names but are considered as part of multi-element apparatuses. However, actual reconstructions of apparatuses has not been attempted. This is necessistated by three factors: 1) individual samples contain at most several hundred elements and many contain far fewer. Thousands of elements are needed for accurate reconstructions of apparatuses from disaggregated sample residues. 2) Most samples contain several platforms to which the ramiform elements could belong. 3) Many ramiform elements are broken and identification even to the element level (i.e., A1, O1, ect) is often tenuous.

Platform elements are considered in more detail than the cones or ramiform elements. This is because identifications can be made accurately, P elements can often be the characteristic components of conodont apparatuses and, most importantly, they are biostratigraphically significant.

SYSTEMATIC PALEONTOLOGY

Discussions of non-ramiform conodont elements are presented in alphabetic order. In the synonomies, only the references used for identification are given. Referral may be made to more complete synonomies. Possible apparatus compositions based on similar taxa described by other workers are given for each genus. Observations concerning the occurrences of such associations, in the studied material, are given, where appropriate, in the Discussions.

In the following discussions, the use of Linnean form names is occasionally necessary for clarity. They are enclosed in quotation marks; Linnean biologic taxa names are not enclosed in quotes.

Genus ANCRYODELLA Ulrich & Bassler, 192

<u>Type species</u>.- <u>Ancryodella nodosa</u> Ulrich & Bassler, 1926, p. 48, pl. 1, figs. 10-13, from the Rhinestreet Shale, New York; by original designation.

<u>Diagnosis</u>.- See ZIEGLER, 1973 .

<u>Multielement relationships</u>.- Klapper and Phillip(1971) consider <u>Ancryodella</u> to be the P element of

a Type 1 apparatus. Ziegler (1972) suggests that <u>Ancryodella</u> might occur in a platform-only apparatus. No relationships are indicated in this study.

ANCRYODELLA CURVATA (Branson & Mehl, 1934)

Pl. 4, fig. 8

<u>Ancryodella</u> <u>curvata</u> (Branson & Mehl)- ZIEGLER, 1958, p. 41, pl. 11, fig. 5

<u>Remarks</u>.- One broken specimen was found but it did exhibit the strongly curved platform margins and surface ornamentation that is characteristic of <u>A</u>. <u>curvata</u>

<u>Material</u> <u>studied</u>.- One specimen .

<u>Occurrence</u>.- Sample [illegible]

<u>Figured</u> <u>specimen</u>.- WVGS [illegible]

ANCRYO[illegible] Branson & [illegible] 19[illegible]

Pl. 4, f[illegible] 3

<u>Ancryodella</u> <u>lobata</u> Branson & Mehl, SEDDON, 1970, pl. 16, fig. 2.

<u>Remarks</u>.- Specimens from the Mason County core are very small and are assigned to this taxon on the basis of platform outline.

<u>Material</u> <u>studied</u>.- Four specimens .

<u>Occurrence</u>.- Samples 44, 45, 59 and 72 .

Figured specimen.-WVGS410061 .

ANCRYODELLA SP. A

Pl. 4, fig. 5

Description.- The platform of this specimen is coarsely nodose with two large lobes on either side of the carina. One of the nodes points posteriorly and one points anteriorly. The carina is robust, almost smooth and slightly curved. The anterior blade and posterior platform are broken. The pit and secondary keels are extremely expanded and are asymmetrical in the same manner as the platform.

Material studied.- One specimen .

Occurrence.- Sample 3[illegible]

Figured specimen.-WVGS410062 .

Genus ANCRYOGNATHUS Branson & Mehl, 1934

Type species.- Ancryognathus symmetricus BRANSON & MEHL, 1934, p. 240, pl. 19, figs. 7-9, from the Grassy Creek Shale, Missouri; by original designation.

Diagnosis.- See ZIEGLER, 1973 .

Multielement relationships.- Ziegler(1972) suggests that this genus might occur in a platform-only apparatus.

This genus is rare in the Mascn County core.

ANCFYOGNATHUS ASYMMETRICUS (Ulrich & Bassler, 1926)

Pl. 4, fig. 1

Ancryognathus asymmetricus (Ulrich & Bassler)- Ziegler, 1958, pl. 10, figs. 10,11.

Remarks.- The specimens frcm the Mason County core are identified by their ccnvex platform outline and sharply terminated lobes.

Material studied.- Four specimens .

Occurrence.- Samples 39, 47 and 53 .

Figured specimen.-WVGS4[illegible]02.

ANCRYOGNATHUS cf. BIFURCATA (Ulrich & Bassler, 1926)

Pl. 4, fig. 2

Ancryognathus bifurcata(Ulrich & Bassler)- ZIEGLER, 1958, p. 47, pl. 10, figs. 9, 13, 14, 16-18.

Remarks.- The specimens recovered from the Mason County core resemble A. bifurcata except that the secondary carina is strong at the platform margins but does not continue to the primary carina. The specimens illustrated by Ziegler(1958) show the secondary carina joined to the primary carina. The primary and secondary keels in this specimen are similar to those of A.

bifurcata. In addition, these specimens occur in a stratigraphically higher position than would be expected for the genus Ancryognathus. The specimen of Ancryodella sp. A found in sample 30 also occurs in an anomalously high position. They are milky-brown in color and may be reworked. However, Ziegler (1962, pl. 9, figs. 13,14) reported the occurrence of Ancryognathus? sp. from a stratigraphically high position in Germany.

Material studied.- Six specimens .

Occurrence.- Samples 23, 32, 33 and 35 .

Figured specimen.-WVGS410063 .

ANCRYOGNATHUS SINELAMINA (Branson & Mehl, 1934)

Pl. 4, fig. 7

Ancryognathus sinelamina (Branson & Mehl). ZIEGLER, 1962, p. 50, pl. 9, figs. 7-12.

Remarks.- A. sinelamina is a lanceolate form without lobes. One small specimen was recovered.

Material studied.- One specimen .

Occurrence.- Sample 33 .

Figured specimen.-WVGS410064 .

ANCRYOGNATHUS SP. INDET

Remarks.- Several specimens of Ancryognathus were found that were too broken to allow a specific determination.

Material studied.- Three specimens .

Occurrence.- Samples 2, 23, 30, 32, 33, 35, 57, 59 and 72 .

ANCRYOGNATHUS SP. A

Pl. 4, fig. 6

Description.- A species of *Ancryognathus* that possesses an highly restricted platform that is present only above the keels. The primary keel is straight and possesses a small pit at midlength. The secondary keel diverges at right angles from the pit but quickly curves posteriorly to almost parallel the primary keel.

Remarks.- This specimen is very small. Surface ornamentation is obscured by silica (determined by x-ray spectrometry) overgrowths.

Material studied.- One specimen .

Occurrence.- Sample 59 .

Figured specimen.-WVGS410065 .

ANCRYOGNATHUS TRIANGULARIS Youngquist, 1957

Pl. 4, fig. 4

Ancryognathus triangularis Youngquist- ZIEGLER, 1958, p. 49, pl. 10, figs. 1-8, 12, 15, 20(see for additional synonymy).

Remarks.- The specimen recovered in this study is very small. The posterior half of the platform is broken off leaving only the anterior half and the lobe. The lobe is rather small.

Material studied.- One specimen .

Occurrence.- Sample 59 .

Figured specimen.-WVGS410066 .

Genus INDETERMINANT A

Pl. 5, fig. 1

Description.- The specimen bears a strong resemblance to Polygnathus except that the platform is highly asymmetrical. The right side of the platform is wide with a trough seperating the margin from the carina. The left side of the platform is highly restricted and flat. The carina continues to the posterior tip of the platform. The free blade is composed of three denticles, the highest of which is the most posterior.

Material studied.- One specimen .

Occurrence.- Sample 4 .

Figured specimen.-WVGS410067 .

Genus ICRIODUS Branson & Mehl, 1938

Type species.- Icriodus expansus BRANSON & MEHL, 1938, p.

160, pl. 26, figs. 18-21, from the Middle Devonian Mineola Limestone, Missouri; by original designation.

Diagnosis.- See KLAPPER AND ZIEGLER, 1975.

Multielement relationships.- Klapper and Phillip(1971) consider "Icriodus" to be the icriodontan(I) element of the Type 4 apparatus. The apparatus is completed by two S1 or S2 elements. Klapper and Ziegler(1975) suggest that Icriodus might also contain an unornamented cone(M2). van den Boogaard and Kuhry(1979) present strong evidence that "Icriodus" and simple cones did not belong in the same apparatus. In this study, "Icriodus" is found with simple cones in samples from the Onondaga Limestone. However, shale samples 1-4, 6, 16 and 17 contain S2 elements but not I elements and samples 11, 22, 38, 53, 57, 59, 64, 65, 71, 73 and 75 contain I elements but not S2 elements. Only samples 70 and 72 contain both S2 and I elements. Therefore, Klapper and Phillip's Icriodus apparatus composition is not supported by this study.

ICRIODUS CORNIGER Wittekindt, 1966

Pl. 3, figs. 12, 13

Icriodus corniger Wittekindt, ZIEGLER, 1975, p. 95, pl. 7, figs 1-5.

Remarks.- "Icriodus corniger" is characterized by an asymmetrical basal margin outline and a pronounced anterior sinus. Well preserved specimens from the Onondaga Limestone exhibit these characters. "*I. corniger*" occurs together with adenticulate cones (presumably the S2 element) in the material studied.

Material studied.- Forty-six specimens .

Occurrence.- Samples 78, 79, 80 and 81 .

Figured specimen.-WVGS410068 .

ICRIODUS CORNUTUS Sannemann, 1955

Pl. 3, fig. 14

Icriodus cornutus SANNEMANN, 1955, p. 130, pl. 4, figs. 19-21; ZIEGLER, 1975, p. 101, pl. 8, fig. 6

Remarks.- Most specimens recovered in this study are very small but do possess the prominent posterior cusp that is characteristic of this species.

Material studied.- Ten specimens.

Occurrence.- Samples 1, 22, 50, 53, 57 and 64.

Figured specimen.-WVGS410069 .

ICRIODUS SYMMETRICUS Branson & Mehl, 1934

Pl. 3, fig. 5

Icriodus symmetricus Branson & Mehl- KLAPPER, 1975, p. 151, pl. 3, figs. 7,8.

Remarks.- Specimens from this study have been identified by the characteristically slender platform and subcircular outline of the posterior basal margin. In some specimens, the basal margin has been broken and identification has been tentatively made on the basis of platform morphology and co-occurrence with well preserved specimens of _I. symmetricus_.

Material studied.- Fifty-seven specimens .

Occurrence.- Samples 57, 59, 65, 70-73 and 75 .

Figured specimen.-WVGS410069 .

Genus OZARKODINA Branson & Mehl, 1933

Type species.- _Ozarkodina typica_ Branson & Mehl, 1933, p. 51, from the Bainbridge(Silurian) of Missouri(by original designation).

Diagnosis.- See KLAPPER, [illegible]

Multielement relationships.- _Ozarkodina_ is composed of a spathognathodontan(P) element, an ozarkodinan(O1) element, a neoprioniodontan or synprioniodinan(N) element, a hindeodellan(A1) element, a plectospathodontan(A2) element and a trichonodellan(A3) element. It is identical to _Pandorinellina_ except that the latter has a diplododellan A3 element.

Remarks.- For reasons mentioned previously, _Ozarkodina_ apparatuses could not be reconstructed. The apparatus elements often co-occur in study material.

Specimens of the O1 element are often broken and only one taxon could be identified. The presence of Ozarkodina in the Mason County well is often indicated soley by the presence of the P element. P elements(designated "Spathognathodus") are therefore indicated on the range chart(Plate 1).

OZARKODINA IMMERSA (Hinde, 1879)

Ctenognathus elegans STAUFFER, 1938, p. 424, pl. 48, figs. 9, 12.

Ozarkodina elegans Sannemann, BISCHOFF & ZIEGLER, 1957, pl. 20, figs. 29-33.

Ozarkodina immersa (Hinde)- CLARK & ETHINGTON, 1967, p. 48, pl. 6, fig. 10.

Remarks.- Specimens possessing a moderately curved blade and slender, reclined, confluent, denticles are identified as O. immersa.

Material studied.- [illegible] specimens.

Occurrence.- Samples 1, 6, 9, 15-17, 23, 28, 30, 33, 35, 38-41, 44, 47, 50, [illegible], 70-72, [illegible]4 and 75.

Figured specimen.-WVGS#10070(not figured).

OZARKODINA SP. A

Pl. 5, fig. 2

Description.- The blade is strongly curved and the denticles are reclined. The cusp is short but very thick and broad. The pit is small.

Material studied.- Nineteen specimens .

Occurrence.- Samples 12, 17 and 32 .

Figured specimen.-WVGS410071 .

OZARKODINA SP. INDET

Remarks.- Many specimens of *Ozarkodina* are fragmentary and could not be identified to the species level.

Material studied.- Forty-two specimens .

Occurrence.- Samples 1-4, 6, 7, 11, 17, 23, 27, 28, 35, 44, 48, 61, 67, 70 and 74 .

Genus PALMATOLEPIS Ulrich & Bassler, 1926

Type species.- *Palmatolepis perlobata* ULRICH & BASSLER, 1926, p. 49, pl. 7, fig. 22, from the Hardin Sandstone near Mount Pleasant, Tennessee; by original designation. Lectotype chosen by Muller (1956, p. 15) and illustrated by Huddle (1968, pl. 15, fig. 2).

Diagnosis.- see ZIEGLER, 1973., p. 253 .

Multielement relationships.- Ziegler(1972) suggests that *Palmatolepis* may belong to a platform-only apparatus. However, v.d. Boogaard and Kuhry(1979) suggest that the *Palmatolepis* apparatus consisted of palmatolepan(P) elements, tripodellan or nothognathellan (O) elements, palmatolepan and smithiform(N) elements and a symmetry transition series consisting of falcodontan(A1), asymmetrical scutulan(A2) and symmetrical scutulan(A3) elements.

In this study material <u>Palmatolepis</u> occurs at times with some or all of the above elements. However, accurate identification of ramiform elements was often impossible. <u>Nothognathella</u> could be identified but occurred too infrequently to permit a detailed consideration of the <u>Palmatolepis</u> apparatus.

PALMATOLEPIS GIGAS Miller & Youngquist, 1947

Pl. 2, fig. 1

<u>Palmatolepis</u> <u>gigas</u> Miller & Youngquist- ZIEGLER, 1973, p. 273, pl. 2, figs. 2,3 (see for additional synonymy).

<u>Remarks</u>.- Specimens from this study are fragmentary but exhibit the diagnostic outer lobe, coarsely nodose surface and sigmoidal blade-carina.

<u>Material</u> <u>studied</u>.- Four specimens .

<u>Occurrence</u>.- Samples 57 and 66 .

<u>Figured</u> <u>specimen</u>.-WVGS410072 .

PALMATOLEPIS GLABRA ACUTA Helms, 1963

Pl. 2, fig. 2

<u>Palmatolepis</u>(<u>Panderolepis</u>) <u>serrata</u> <u>acuta</u> HELMS, 1963, p.

468, pl. 3, figs. 1-4.

<u>Palmatolepis</u> <u>glabra</u> <u>scuta</u> Helms- BOUCKAERT & ZIEGLER, 1965, pl. 3, fig. 7; ZIEGLER, 1973, p. 293, pl. 6, figs. 2,3 (See for additional synonymy).

<u>Remarks</u>.- This subspecies is characterized by a parapet that forms an acute angle with the blade.

<u>Material</u> <u>studied</u>.- One specimen .

<u>Occurrence</u>.- Sample 28 .

<u>Figured</u> <u>specimen</u>.-WVGS410073 .

PALMATOLEPIS GLABRA DISTORTA Branson & Mehl, 1934

Pl. 2, fig. 3

<u>Palmatolepis</u> <u>distorta</u> BRANSON & MEHL, 1934, pl. 18, fig. 13.

<u>Palmatolepis</u> (<u>Panderolepis</u>) <u>distorta</u> <u>distorta</u> Branson & Mehl- HELMS, 196[illegible], text-fig. 2, fig. 26.

<u>Palmatolepis</u> <u>glabra</u> <u>distorta</u> Branson & Mehl- ZIEGLER, 1973, p. 297, pl. 6, figs. 4-6.

<u>Remarks</u>.- This subspecies is characterized by a narrow, sigmoidal platform and a parapet that parallels the blade. Specimens from this core are generally fragmentary but exhibit these characters.

<u>Material</u> <u>studied</u>.- Nine specimens .

<u>Occurrence</u>.- Sample 3 .

Figured specimen.-WVGS410074 .

PALMATOLEPIS GRABRA LEPTA Ziegler & Huddle, 1969

Pl. 2, fig. 4

Palmatolepis glabra lepta ZIEGLER & HUDDLE, 1969, p. 380-381; ZIEGLER, 1973, p. 301, pl. 7, figs. 1-3(see for additional synonymy).

Remarks.- This subspecies has an extremely slender platform with a triangular parapet. The specimens from this core are badly broken but exhibit the markedly triangular parapet.

Material studied.- Three specimens .

Occurrence.- Samples 6 and 28 .

Figured specimen.-WVGS4100[illegible]5

PALMATOLEPIS GLABRA PECTINATA Ziegler, 1962

Pl. 2, fig. 5

Palmatolepis glabra pectinata Ziegler- ZIEGLER, 1973, p. 305, pl. 6, figs. 7-11(see for additional synonymy).

Remarks.- This subspecies possesses a sharp parapet that parallels and is close to the blade.

Material studied.- Thirty-four specimens .

Occurrence.- Samples 6 and 17 .

Figured specimen.-WVGS410C76 .

PALMATOLEPIS GLABRA PRIMA Ziegler & Huddle, 1969

Pl. 2, fig. 6

Palmatolepis glabra prima Ziegler & Huddle- ZIEGLER, 1973, p. 309, pl. 7, figs. 4-7(see for additional synonymy).

Remarks.- This subspecies possesses a short, rounded parapet. This subspecies is usually fragmentary and has been identified on the basis of parapet form.

Material studied.- Eight specimens .

Occurrence.- Samples 6 and 30 .

Figured specimen.-WVGS410077.

PALMATOLEPIS GLABRA ssp.

Remarks.- Fragmentary palmatolepids exhibiting a slender platform and parapet have been assigned to _P. glabra_ without any attempt at subspecification.

Material studied.- 114 specimens .

Occurrence.- Samples 1, 4, 5, 9-12, 14, 15-17, 19, 22, 23, 26, 30 and 32. .

PALMATOLEPIS MARGINIFERA MARGINIFERA Helms, 1959

Pl. 2, fig. 7

Palmatolepis quadrantinodosa marginifera Ziegler- HELMS, 1959, pl. 5, figs. 22, 23.

Palmatolepis marginifera marginifera Helms- ZIEGLER, 1973, p. 327, pl. 7, figs. 17-18, pl. 8, figs. 1,2.

Remarks.- Many well-preserved specimens were recovered and are distinguished from *P. stopelli* on the basis of parapet form.

Material studied.- Forty-three specimens .

Occurrence.- Samples 3, 4, 6 and 17 .

Figured specimen.-WVGS410078 .

PALMATOLEPIS MINUTA MINUTA Branson & Mehl, 1934

Pl. 2, fig. 8

Palmatolepis minuta minuta Branson & Mehl- ZIEGLER, 1973, p. 335, pl. 9, figs. 1-5.

Remarks.- *P. minuta minuta* is a small palmatolpean with a rather variable outer lobe. The specimens recovered in this study are probably juveniles of other forms but do possess the characters diagnostic of *P. minuta minuta*.

Material studied.- Seventy-five specimens .

Occurrence.- Samples 9, 11, 15, 16, 18, 24, 27, 28 and 31-33. .

Figured specimen.-WVGS410100 .

PALMATOLEPIS PERLOBATA GROSSI Ziegler, 1960

Palmatolepis perlobata grossi Ziegler- ZIEGLER, 1973, p. 353, pl. 10, figs. 1-4 (see for additional synonomy).

Remarks.- Only two specimens were recovered and these were reassembled from disjoint fragments. One specimen is complete when reassembled from disjoint fragments. However, neither could be photographed because of their broken condition.

Material studied.- Two specimens .

Occurrence.- Samples 2 and 17 .

Type Specimen.-WVGS410079.

PALMATOLEPIS PERLOBATA SCHINDEWOLFI Muller, 1956

Pl. 2, [illegible]

Palmatolepis perlobata schindewolfi Muller- ZIEGLER, 1977, p. 361, pl. [illegible], figs. [illegible] (see for additional synonomy).

Remarks.- Many well preserved specimens were recovered.

Material studied.- Thirty-eight specimens .

Occurrence.- Samples 2,23 and 28-33 .

Figured specimen.-WVGS410080 .

PALMATOLEPIS PROVERSA Ziegler, 1958

Pl. 2, fig. 10

Palmatolepis proversa Ziegler- ZIEGLER, 1973, p. 289, pl. 2, fig. 5.

Remarks.- Specimens recovered in this study exhibit the charactistic strongly sigmoidal blade and anteriorly situated outer lobe.

Material studied.- Eleven specimens .

Occurrence.- Samples 68, 72 and 75 .

Figured specimen.-WVGS410081 .

PALMATOLEPIS QUADRANTINODOSA INFLEXA Muller, 1956

Pl. 2, fig. 11

Palmatolepis (Palmatolepis) inflexa MULLER, 1956, pl. 10, fig. 5.

Palmatolepis quadrantinodosa inflexa Muller- ZIEGLER, 1973, p. 377, pl. 12, figs. 3-10 (see for additional synonymy).

Remarks.- This subspecies is distinguished from the nominate subspecies by the smooth parapet.

Material studied.- Twenty-two specimens .

Occurrence.- Samples 9, 11 and 17 .

Figured specimen.-WVGS410082 .

PALMATOLEPIS QUADRANTINODOSA QUADRANTINODOSA Branson & Mehl, 1934

Pl. 2, fig. 12

Palmatolepis quadrantinodosa quadrantinodosa Branson & Mehl- ZIEGLER, 1962, pl. 7, figs. 10,11; ZIEGLER, 1973, p. 371, pl. 8, figs. 10-16.

Remarks.- This subspecies is characterized by a nodose parapet. Specimens recovered in this study exhibit this character and are especially well preserved.

Material studied.- Sixteen specimens .

Occurrence.- Sample 17 .

Figured specimen.-WVGS410083 .

PALMATOLEPIS QUADRANTINODCSALOBATA Sannemann, 1955

Pl. 2, fig. 13

Palmatolepis quadrantinodosalobata Sannemann- ZIEGLER, 1973, p. 295, pl. 4, figs. 6-8 (see for additional synonomy).

Remarks.- Specimens from this study resemble Morphotype 1 of Sandberg & Ziegler (1973) in that only the parapet is strongly nodose; the remainder of the platform is shagreen-like.

Material studied.- Four specimens .

Occurrence.- Samples 37 and 38 .

Figured specimen.-WVGS410084 .

PALMATOLEPIS cf. REGULARIS Cooper, 1931

Pl. 2, fig. 14

Palmatolepis cf. regularis Cooper- ZIEGLER, 1962, p. 75, pl. 6, figs. 20-24.

Remarks.- This species is characterized by a strongly sigmoidal blade-carina. The specimens recovered from the Mason County core have platforms that are almost symmetrical about the carina. The specimens illustrated by Ziegler(1962) have both symmetrical and asymmetrical platforms.

Material studied.- Seventeen specimens .

Occurrence.- Samples 30 and 35 .

Figured specimen.-W[illegible]8[illegible].

PALMATOLEPIS RHOMBOIDEA Sannemann, 1955

Pl. 2, fig. 15

Palmatolepis rhomboidea SANNEMANN, 1955, p. 329, pl. 24, fig. 14; ZIEGLER, 1975, p. 299, pl. 1, figs 6,7(see for additional synonymy).

Remarks.- Specimens from the Mason County core are very small but exhibit the characteristic rhomb-shaped platform.

Material studied.- Two specimens .

Occurrence.- Sample 21 .

Figured specimen.-WVGS410086 .

PALMATOLEPIS SUBPERLOBATA Branson & Mehl, 1934

Pl. 2, fig. 16

Palmatclepis subperlobata Branson & Mehl- ZIEGLER, 1962, p.79, pl. 4, figs. 1,2.

Remarks.- This species is distinguished from P. triangularis by its less sigmcidal carina.

Material studied.- Sixty specimens .

Occurrence.- Samples 35 and 37 .

Figured specimen.-WVGS410C87 .

PALMATOLEPIS cf. TRIANGULARIS Sannemann, 1955

Pl. 2, fig. 17

Palmatclepis triangularis Sannemann- ZIEGLER, 1973, p. 311, pl. 3, figs. 1,2(see for additional synonymy).

Remarks.- Specimens frcm the Mason County core are largely fragmentary but appear to exhibit the triangular platform outline and coarsely ncdcse upper surface that is characteristic of P. triangularis. Positive identification may, however, be somewhat problematic.

Material studied.- Seven specimens .

Occurrence.- Sample 38 .

Figured specimen.-WVGS410088 .

Genus POLYGNATHUS Hinde, 1879

Type species.- *Polygnathus dubius* HINDE, 1879(by subsequent designation, MILLER, 1889, p. 20).

Diagnosis.- See KLAPPER and ZIEGLER, 1973, p. 333. .

Multielement relationships.- The *Polygnathus* apparatus as reconstructed by Klapper & Phillip(1971, 1972) consists of a polygnathan(P) element, an ozarkodinan(O1) element, a neoprioniodontan or synprioniodinan(N) element, a hindeodellan(A1) element, an angulodontan or plectospathodontan(A2) element and a diplododellan or hibbardellan(A3) element. The O1, N and A1-A3 elements have, in one sample or another, been found in conjunction with P elements. However, many of the former elements are also found in the *Ozarkodina* apparatus. As *Ozarkodina* also occurs in most samples no unequivocal reconstruction of either apparatuses could be made.

In Onondaga samples 77, 78 and 81, the *P. linguiformis linguiformis* apparatus does occur(the A3 element is missing however). No *Ozarkodina* occurs in these samples.

Remarks.- The most common polygnathan P elements in the Mason County core are juveniles. Presumably they are representatives of *P. webbi*, *P. decorosus* and *P. glaber*, with whose adult forms they often co-occur.

POLYGNATHUS BICAVATA Ziegler, 1962

Pl. 3, fig. 1

Polygnathus bicavata ZIEGLER, 1962, p. 86, pl. 10, figs. 1, 3, 6-8.

Remarks.- Only one side of the platform is preserved. However, the strong depression of the platform about midlength and the small basal pit indicate that this specimen is *P. bicavata*.

Material studied.- One specimen .

Occurrence.- Sample 2 .

Figured specimen.-WVGS410089 .

POLYGNATHUS cf. GLABER Ulrich & Bassler, 1926

Polygnathus glaber Ulrich & Bassler- HUDDLE, 1968, pl. 15, figs. 13-17.

Remarks.- Specimens assigned to this taxon bear resemblence to *P. glaber* in platform outline. The platform is smooth except for a sharply pointed node that occurs on each platform margin about midway along the platform.

Material studied.- Two specimens .

Occurrence.- Samples 6 and 11 .

Type specimen.-WVGS410090.

POLYGNATHUS COSTATUS COSTATUS Klapper, 1971

Pl. 3, fig. 2

Polygnathus costatus costatus KLAPPER, 1973, p. 347, pl. 1, fig. 3(see for additional synonomy).

Remarks.- Specimens recovered from the Onondaga Limestone are usually well preserved but often have quartz overgrowths on them. In most specimens, the characteristic anterior constriction of the platform can be observed.

Material studied.- Seventy-two specimens .

Occurrence.- Sample 78 .

Figured specimen.-WVGS410101 .

POLYGNATHUS COSTATUS PATULUS Klapper, 1971

Pl. 3, fig. 3

Polygnathus costatus patulus Klapper- KLAPPER, 1973, p. 349, pl. 1, fig. 6(see for additional synonomy).

Remarks.- The broad platform and less constricted anterior platform distinguishes this subspecies from *P. c. costatus*. Two well preserved specimens were recovered from the Onondaga Limestone.

Material studied.- Two specimens .

Occurrence.- Sample 79 .

Figured specimen.-WVGS410091 .

POLYGNATHUS DECORCSUS Stauffer, 1938

Pl. 3, fig. 4

Polygnathus decorosus Stauffer- KLAPPER, 1973, p. 351, pl. 1, fig. 5(see for additicnal synonomy).

Remarks.- This long-ranging species is found throughout a large porticn cf the Mason County core. It often co-occurs with *P. webbi* and is distingushed from the latter by the narrow, saggitate platform.

Material studied.- 277 specimens .

Occurrence.- Samples 5[illegible]7, 70-72, 74 and 75 .

Figured specimen.-WVGS410092 .

POLYGNATHUS GLABER GLABER Ulrich & Bassler, 1926

Pl. 3, fig. 11

Polygnathus glabra Ulrich & Bassler- HUDDLE, 1968, p. 39, pl. 15, figs. 13-17.

Polygnathus glabra glabra Ulrich & Bassler- SEDDON, 1970, pl. 18, figs. 16,17.

<u>Polygnathus glaber glaber</u> Ulrich & Bassler- KLAPPER, 1975, p. 283, pl. 5, fig. 1.

<u>Remarks</u>.- This taxon is characterized by a smooth platform with deep troughs on both sides of the carina. Most specimens are very small and broken.

<u>Material studied</u>.- Forty-seven specimens .

<u>Occurrence</u>.- Samples 6, 15, 16, 17, 27, 28, 33, 35 and 37 .

<u>Figured specimen</u>.-WVGS410093 .

POLYGNATHUS LINGUIFORMIS LINGUIFORMIS Hinde, 1874

gamma morphotype Bultynck, 1970

Pl. 3, fig. 5

<u>Polygnathus linguiformis linguiformis</u> Hinde, gamma morphotype Bultynck- KLAPPER, 1977, p. 461, pl. 9, figs. 2, (see for additional synonymy

<u>Remarks</u>.- The gamma morphotype of this subspecies is highly variable but is distinguished by an [illegible]like expansion of the platform immediately anterior to the tongue. The tongue is short in relation to the length of the platform. This is the only morphotype of <u>P. l. linguiformis</u> recovered from the Mason County core and is common in the Onondaga Limestone. It also occurs at the base of the shale section.

<u>Material studied</u>.- Twenty specimens .

Occurrence.- Samples 77, 78, 81 and 80 .

Figured specimen.-WVGS410103 .

POLYGNATHUS NODOCOSTATUS Branson & Mehl, 1934

Pl. 3, figs. 8,9

Polygnathus nodocostata Branson & Mehl- HELMS, 1959, p. 686.

Remarks.- Two specimens of *P. nodocostata* were found. One spcimen, from sample 1, possesses a curved platform with nodes in rows that curve with the platform. This is probably *P. n. nodocostata*. The other specimen, from sample 33, possesses a straight, almost flat platform and is probably *P. n. ovata*.

Material studied.- Two specimens .

Occurrence.- Samples 1 and 33 .

Figured specimen.-WVGS41C095 and WVGS410104 .

POLYGNATHUS SP.

Pl. 3, fig. 7

Description.- The platform has one row of marginal nodes on each side of the carina and a deep trough separating them from the carina. The nodes and carina continue almost to the posterior tip. The posterior tip is bowed downward. The free blade is continuous with the carina and rises sharply anterior of the platform. The most anterior denticle is highest. The pit is small and is located at the anterior end of the platform.

<u>Remarks</u>.- The right side of the platform is broken off. The blade is also broken. This specimen does not resemble any other polygnathans that I have seen.

<u>Material studied</u>.- One specimen .

<u>Occurrence</u>.- Sample 27 .

<u>Figured specimen</u>.-WVGS410096 .

POLYGNATHUS WEBBI Stauffer, 1938

Pl. 3, fig. 6

<u>Polygnathus webbi</u> STAUFFER, 1938, p. 439, pl. 53, figs. 25, 26, 28, 29; KLAPPER, 1973, p. 393, pl. 2, fig. 7 (see for additional synoncmy).

<u>Remarks</u>.- This species is characterized by a somewhat expanded platform with strong [illegible] It is abundant in the Mason County core.

<u>Material studied</u>.- 162 specimens

<u>Occurrence</u>.- Samples 6, [illegible] 38-42, 47-51, 53, 57, 59, 61, 65, 67, 70-73 and 75 .

<u>Figured specimen</u>.-WVGS410097 .

Genus POLYLOPHODONTA Branson & Mehl, 1934

<u>Type species</u>.- <u>Polylophodonta concentrica</u> (Ulrich & Bassler)- BRANSON & MEHL, 1934, p. 243, pl. 20, fig.

2 (by subsequent designation).

Diagnosis.- See BRANSON & MEHL, 1934 .

Multielement relationships.- No multielement relationships are known at present for this form genus. However, this genus has similar gross external morphology to *Polygnathus* and is probably homologous to that genus.

POLYLOPHODONTA aff. CONFLUENS (Ulrich & Bassler, 1926)

Pl. 3, fig. 10

Polylophodonta confluens (U&B)- HELMS, 1961, p. 698, pl. 13, figs. 13, 14, 18.

Remarks.- The specimens recovered from the Mason County core are similar to *P. confluens* but differ slightly in platform outline and surface ornamentation. *P. confluens* possesses a platform that tapers sharply posteriorly while the specimens recovered in this study are rather obtuse posteriorly. In addition, the surface ornamentation of *P. confluens* is mainly in the form of distinct nodes. The specimens from this study posses surface ornamentation consisting of nodes that are almost completely fused into ridges. The lower sides of the Mason County specimens are similar to that of *P. confluens* and the overall morphology of the specimens suggest that they are very closely related to *P. confluens*.

Material studied.- Five specimens .

Occurrence.- Samples 2,4,6,12 and 15 .

Figured specimen.-WVGS410100 .

Genus SCAPHIGNATHUS Helms, 1959

Type species.- *Scaphignathus velifera* Ziegler- HELMS, 1959, p. 655, pl. 5, fig. 20(by monotypy).

Remarks.- This genus is composed of three species: *S. velifer*, *S. peterseni*, and *S. ziegleri*. ?*S. subserratus* is currently only tentatively retained in the genus *Scaphignathus*(Sandberg & Ziegler, 1979).

Multielement relationships.- No multielement relationships have been established for this genus.

SCAPHIGNATHUS VELIFER Helms, 1959

Pl. 2, figs. 9-12

Scaphignathus velifer Helms- [illegible], p. 83, pl. 2, figs. 1-6, 8, 9, 11(see for additional synonomy).

Remarks.- The characters that distinguish *S. velifer* from *S. subserratus* are: 1) The free blade is invariably offset to the right and is discontinuous with the carina, and 2) the most posterior denticle of the free-blade is highest. The two sepcimens recovered from the Mason County core exhibit these characters. This appears to be the first recovery of *S. velifer* from North America. Other occurrences are in Germany and Australia.

Material studied.- Two specimens .

Occurrence.- Sample 1 .

Figured specimen.-WVGS410098 and WVGS410099 .

REFERENCES

Barnes, C. R., editor, 1976, Conodont Paleoecology: Geol. Assoc. Canada, Special Paper 15, 324 p.

Beinert, R. J., Klapper, G., Sandberg, C. A., and Ziegler, W., 1971, Revision of Scaphignathus and description of Clydagnathus? ormistoni n. sp. (Conodonta, Upper Devonian): Geologica et Palaeontologica 5: 81-91.

Bischoff, G., and Ziegler, W., 1957, Die Conodontenchronologie des Mitteldevons und des tiefsten Oberdevons: Abh. hess. Landesamt Bodenforsch. 22: 1-36.

Branson, E. B., and Mehl, M. G., 1933, Conodonts from the Bainbridge (Silurian) of Missouri: Univ. Missouri Stud. 8: 39-52.

Branson, E. B., and Mehl, M. G., 1934, Conodonts from the Grassy Creek Shale of Missouri: Univ. Missouri Stud., 8: 171-259.

Branson, E. B., and Mehl, M. G., 1938, The conodont genus Icriodus and its stratigraphic distribution: J. Paleont., 12: 156-166.

Bouchaert, J., and Ziegler, W., 1965, Conodont stratigraphy of the Famenian stage (Upper Devonian) in Belgium with a study of petrology by J. Thorez: Mem. Expl. Cartes Geol. Min., Belg. 5: 1-62.

Clark, D. L., and Ethington, R. L., 1967, Conodonts and zonation of the Upper Devonian in the Great Basin: Geol. Soc. Amer. Mem. 103: 1-94.

Duffield, S. L., 1978, Devonian conodont biostratigraphy in a Lincoln County, West Virginia, core: West Virginia University M. S. thesis(unpub.), 64 p.

Duffield, S. L., and Warshauer, S. M., 1979, Two-step process for extraction of microfossils from indurated organic shales: J. Paleont. 53(3): 746-747.

Duffield, S. L., and Warshauer, S. M., Upper Devonian (Frasnian) conodonts and ostracodes from the subsurface of western West Virginia, Jour. Paleont., in press.

Erwin, R. B., 1980, Petrologic Characterization of Mason 146 (Reel Energy well D&K no. 3), Mason, Co., W. Va., West Virginia Geological and Economic Survey, unpub. manuscript.

Evans, M., 1979, Fractures in Oriented Devonian Shale Cores from the Appalachian Basin: West Virginia University M. S. thesis(unpub.), 278 p.

Gable, K.S., 1973, Conodonts and stratigraphy of the Olentangy shale(Middle and Upper Devonian), central and southcentral Ohio: The Ohio State University M. S. thesis(unpub.), 83 p.

Glenister, B. F., and Klapper, G., 1966, Upper Devonian condonts from the Canning Basin, Western Australia:

J. Paleont. 40: 777-842.

Helms, J., 1959, Conodonten aus dem Saalfelder Oberdevon(Thuringen): Geologie, 8: 634-677.

Helms, J., 1961, Die Beteutung der Conodonten fur die Stratigraphie: Geologie 10: 973-995.

Helms, J., 1963, Zur Phylogenie und Taxonomie von <u>Palmatolepis</u>(Conodontida, Oberdevon): Geologie 12: 449-485.

Hinde, G. J., 1879, On conodonts from the Chazy and Cincinnati Group of the Cambro-Silurian and from the Hamilton and Genessee Shale Division of the Devonian of Canada and the United States: Geol. Soc. London Quart. Jour. v. 35, pt. 3, p. 351-369, pls. 15, 17.

Huddle, J. W., 1968, Redescription of Upper Devonian conodont genera and species proposed bu Ulrich and Bassler in 1926: U. S. Geol. Surv. Prof. Pap. 578, p. 1-55.

Jeppeson, L., 1971, Element arrangement in conodont apparatuses of <u>Hindeodella</u> type and in similar forms: Lethaia, 4:101-123.

Klapper, G., 1973, <u>in</u>, Ziegler, W., editor, Catalogue of Conodonts, v. I: Stuttgart, E. Schweitzerbart'sche Verlabsbuchhandlung, 504. p.

Klapper, G., 1975, <u>in</u>, Ziegler, W., editor, Catalogue of Conodonts, v. II: Stuttgart, E. Schwietzerbart'sche Verlagsbuchhandlung, 404. p.

Klapper, G., 1977, in, Ziegler, W., editor, Catalogue of Conodonts, v. III: Stuttgart, E. Schwietzerbart'sche Verlagsbuchhandlund, 574 p.

Klapper, G., and Johnson, J. G., 1980, Endemism and dispersal of Devonian conodonts: J. Paleont. 54: 400-455.

Klapper, G., and Philip, G. M., 1971, Devonian conodont apparatuses and their vicarious skeletal elements, Lethaia 4: 429-452.

Klapper, G., Sandberg, C. A., Collinson, C., Huddle, J. W., Orr, R. W., Rickard, L. V., Schumacher, D., Seddon, G., and Uyeno, T. T., 1971, North American Devonian conodont biostratigraphy: Geol. Soc. Amer. Mem. 127, p. 285-316.

Klapper, G., and Ziegler, W., 1973, Genus Polygnathus Hinde, 1979, in, Ziegler, W., editor, Catalogue of Conodonts, v. I: Stuttgart, E. Schweitzerbart'sche Verlagsbuchhandlung, p. 3[illegible].

Klapper, G. and Ziegler, W., 1975, Genus Icriodus, in, Ziegler, W., Editor, Catalogue of Conodonts, v. II: Stuttgart, E. Schwietertart'sche Verlagsbuchhandlung, p. 67-68.

Lange, F., 1968, Conodonten-Gruppeffunde aus Kalken des tiefsten Oberdevon: Geologica et Palaeontologica 2: 37-57.

Lindstrom, M., 1973, On the affinities of conodonts: Geol.

Soc. Amer. Special Paper 141, p. 85-102.

Miller, S. A., 1889, North American geology and paleontology for the use of amateurs, students and scientists: Western Methodist Book Concern, 1-718, Cincinnati, Ohio.

Muller, K. J., 1956, Taxonomy, nomenclature, orientation and stratigraphic evaluation of conodonts: J. Paleont. 30: 1324-1340, pl. 45.

Pander, C. J., 1856, Monographie der fossilen Fische des silurischen Systems der russich-baltischen Gouvernments: Konigl. Akad. Wiss., St. Petersburg., 91p.

Patchen, D. G., 1977, Subsurface stratigraphy and gas production of the Devonian Shales in West Virginia: ERDA Morgantown Energy Research Center MERC/CR-77/5, 35p.

Ramsey, N. J., 1969, Upper Emsian-Upper Giventian conodonts from the Columbus and Delaware Limestones and Lower Olentangy Shale of central Ohio: The Ohio State University M. S. thesis (unpub.), 74 p.

Rhoades, F. H. T., 1952, A classification of Pennsylvanian Conodont assemblages, J. Paleont. 27: 610-612.

Rhoades, S., Vickrers, H., Easterday, B., Clarkson, G., Gerrard, S., 1978, Preliminary description of DOE/EGSP Core 41(Mason County-146): West Virginia Geological Survey, unpub. manuscript.

Rickard, L. V., 1975, Correlation of the Silurian and Devonian rocks in New York State: New York State Museum and Science Service Map and Chart Series Number 24, Albany, New York.

Roen, J. B., Wallace, L. G., and deWitt, W., Jr., 1978, Preliminary stratigraphic cross section showing radioactive zones in the Devonian black shales in the central part of the Appalachian Basin: U. S. Geol. Surv. Oil and Gas Invest. Chart OC-87.

Sandberg, C. A., and Ziegler, W., 1973, Refinement of the standard Upper Devonian conodont zonation based on sections in Nevada and West Germany: Geologica et Palaeontologica 7: 97-122.

Sandberg, C. A., and Ziegler, W., 1979, Taxonomy and biofacies of important conodonts of the Late Devonian styriacus-Zone, United States and Germany: Geologica et Palaeontologica 13: 173-212.

Sannemann, D., 1955, Oberdevonische Conodonten(to II alpha): Senckenbergiana leth. 36: 123-156.

Schmidt, H., 1934, Conodonten-Funde in ursprunglichen zusammenlung: Paleontologisches Zeitschrift, 16: 76-85.

Schwietering, J., 1979, Devonian shales of Ohio and their eastern and southeastern equivalents: DOE Morgantown Energy Technology Center METC/CR-79/2, 68 p.

Schumacher, D., 1972, Conodont biostratigraphy and paleoenvironments of Middle and Upper Devonian boundary beds, Missouri: University of Missouri-Columbia Ph. D. dissertation(unpub.), 82 p.

Scott, H. W., 1934, The zoological relationships of the conodonts: J. Paleont. 8: 448-455, pls. 58-59.

Seddon, G., 1970, Frasnian conodonts from the Sadler Ridge-Bulge Gap area, Canning Basin, Western Australia: J. Geol. Soc. Austral. 16: 723-753, pls. 11-16.

Stauffer, C. R., 1938, Conodonts of the Olentangy Shale: J. Paleont, 12: 411-443, pls. 48-53.

Stewart, G. A., and Sweet, W. C., 1956, Conodonts from the Middle Devonian bone beds of central Ohio and west-central Ohio: J. Paleont. 30: 261-273, pls. 33, 34.

Tillman, A., 1969, On the age of the Olentangy shale of central Ohio(abstr.): Geol. Soc. Amer. Abstr. 1969, part 6, p. 49.

Ulrich, E. O., and Bassler, R. S., 1926, A classification of the tooth-like fossils, conodonts, with descriptions of American Devonian and Mississippian species: Proc. U. S. Nat. Mus. 68, art. 12: 1-63.

van den Boogaard, M., and Kuhry, B., 1979, Statistical reconstructions of the Palmatolepis apparatuses (Late Devonian, Conodontophcrids) at the generic, subgeneric and specific level: Scripta Geologica 49, Leiden, 57 p.

Wallace, L. G., Roen, J. B., and deWitt, W., Jr., 1977, Preliminary stratigraphic cross section showing radioactive zones in the Devonian Black Shales in the western part of the Appalachian Basin: U. S. Geol. Surv. Oil and Gas Invest. Chart OC-80.

Wallace, L. G., Roen, J. B., and deWitt, W., Jr., 1978, Preliminary stratigraphic cross section showing radioactive zones in the Devonian Black Shales in southeastern Ohio and west-central West Virginia: U. S. Geol. Surv. Oil and Gas Invest. Chart OC-83.

Walliser, G., 1964, Conodonten des Silurs: Abhandl. Hess. Landesamtes Bodenforsch. 41: 106 p.

Wells, J. W., 1944, Provisional paleoecological analysis of the Devonian rocks of the Columbus region: Ohio Journal of Science, 47:119-126.

West, Mareta, 1978, Preliminary stratigraphic cross section showing radioactive zones in the Devonian Black Shales in the eastern part of the Appalachian Basin: U. S. Geol. Surv. Oil and Gas Invest. Chart OC-86.

Winder, C. G., 1966, Conodont zones and stratigraphic variability in Upper Devonian Rocks, Ontario: J. Paleont. 40: 46-63.

Ziegler, W., 1958, Conodontfeinstratigraphische Untersuchungen an der Grenze Mittledevon/Oberdevon und in der Adorfstufe: Hess. Land. Boden. Notizblatt

87: p. 7-77, 12 pls.

Ziegler, W., 1962, Phylogenetische Entwicklung stratigraphische wichtiger Conodonten-Gatlunger in der Manticoceras-Stufe(Cberdevon, Deutschland): N. Jahr. Geol. Paleont. Abh. 114: 142-168, 14 pls.

Ziegler, W., 1971, Conodont stratigraphy of the European Devonian, in, Sweet, W. C., and Bergstrom, S. M., eds., Symposium on conodont biostratigraphy: Geol. Soc. Amer. Mem. 127: 227-284, Boulder, Colo.

Ziegler, W., 1972, Uber Devonische Conodonten-Apparate: Geologica et Palaeontclcgica SB 1, p. 91-96.

Ziegler, W., 1973, in, Ziegler, W., editor, Catalogue of Conodonts, v. I: Stuttgart, E. Schwietzerbart'sche Verlagsbuchhandlung, 504 p.

Ziegler, W., 1975, in, Ziegler, W., editor, Catalogue of Conodonts, v. II: Stuttgart, E. Schweitzerbart'sche Verlagsbuchhandlung, 404 p.

Ziegler, W., 1977, in, Ziegler, W., editor, Catalogue of Conodonts, v. III: Stuttgart, E. Schwietzerbart'sche Verlagsbuchhandlung, 574 p.

Ziegler, W., and Huddle, J. W., 1969, Die Palmatolepis glabra-Gruppe (Conodonta) nach der Revision der Typen von Ulrich and Bassler durch J. W. Huddle: Fortsch. Geol. Rheinland-Westfal. 16: 377-386, Krefeld.

Ziegler, W., Klapper, G., and Johnson, J. G., 1976, Redefinition and subdivision of the varcus-

Zone (conodonts, Middle?-Upper Devonian) in Europe and North America: Geologica et Palaeontologica 10: 109-140.

EXPLANATION OF PLATE 2

SEM photomicrographs, X70

Color Alteration Index (CAI) is 1.

Fig. 1. Palmatolepis gigas Miller & Youngquist. Upper view of hypotype WVGS410072, from sample 66.

2. Palmatolepis glabra acuta Helms. Upper view of hypotype WVGS410073, from sample 28.

3. Palmatolepis glabra distorta Branson & Mehl. Upper view of hypotype WVGS 41074, from sample 3.

4. Palmatolepis glabra lepta Ziegler & Huddle. Upper view of hypotype WVGS410075, from sample 6.

5. Palmatolepis glabra pectinata Ziegler. Upper view of hypotype WVGS410076, from sample 17.

6. Palmatolepis glabra prima Ziegler & Huddle. Upper view of hypotype WVGS410077, from sample 6. X 70

7. Palmatolepis marginifera marginifera Helms. Upper view of hypotype WVGS410078, from sample 4.

8. Palmatolepis minuta minuta Branson & Mehl. Upper view of hypotype WVGS410100, from sample 30.

9. Palmatolepis perlobata schindewolfi Muller. Upper view of hypotype WVGS410080, from sample 23.

10. Palmatolepis proversa Ziegler. Upper view of hypotype WVGS410081, from sample 75.

11. Palmatolepis quadrantinodosa inflexa Muller.

Upper view of hypovype WVGS410082, from sample 11.

12. _Palmatolepis quadrantinodosa quadrantinodosa_ Branson & Mehl. Upper view of hypotype WVGS410083, from sample 17.

13. _Palmatolepis quadrantinodosalobata_ Sannemann. Upper view of hypotype WVGS410084, from sample 37.

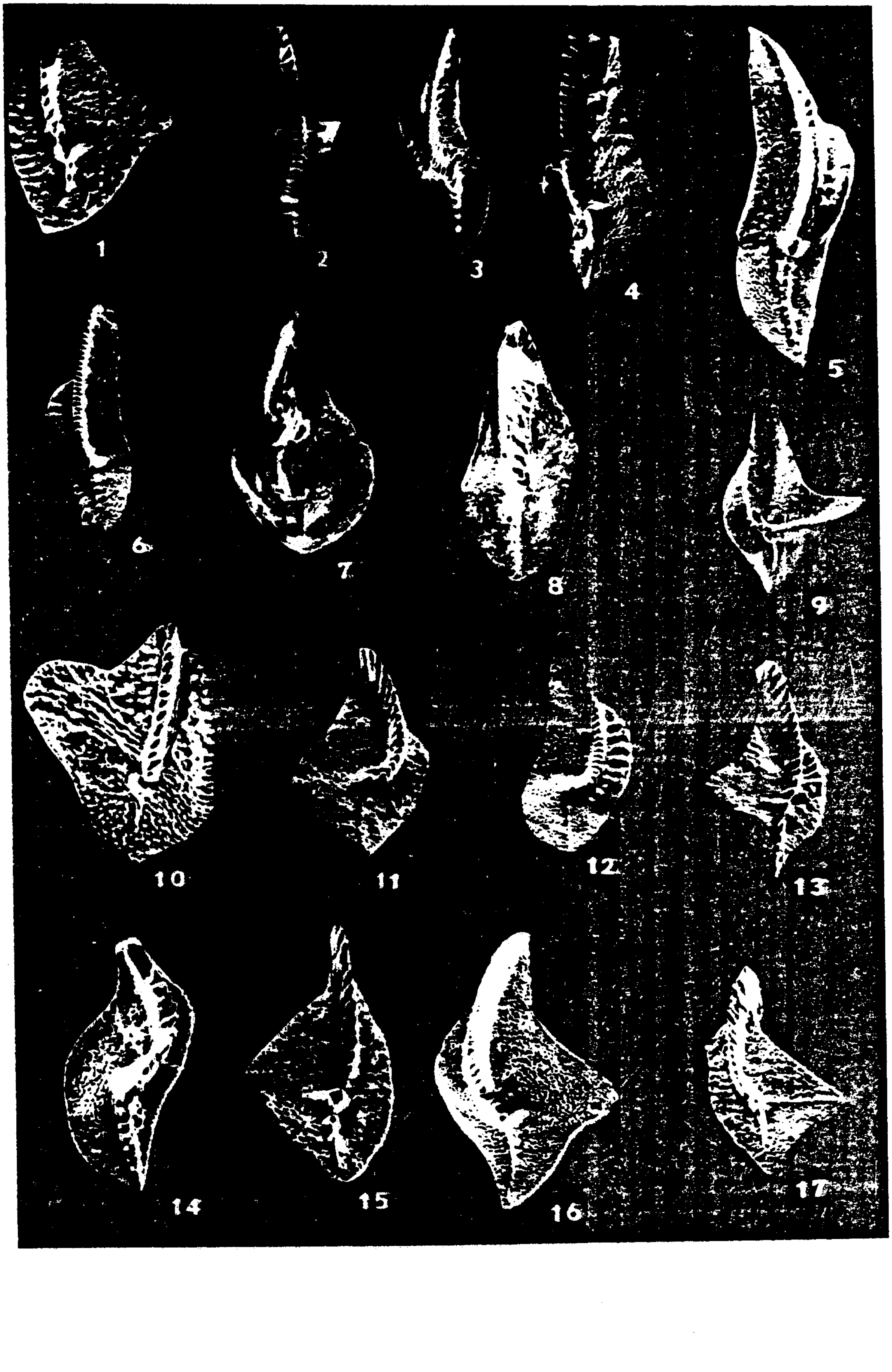
14. _Palmatolepis_ cf. _regularis_ Cooper,. Upper view of hypotype WVGS410C85, from sample 30.

15. _Palmatolepis rhombcidea_ Sannemann. Upper view of hypotype WVGS410086, from sample 21.

16. _Palmatolepis subperlcbata_ Branson & Mehl. Upper view of hypotype WVGS410C87, from sample 35.

17. _Palmatolepis_ cf. _triangularis_ Sannemann. Upper view of hypotype WVGS410088, from sample 39.

PLATE 2



EXPLANATION OF PLATE 3

SEM photomicrographs; all specimens X70

Color Alteration Index (CAI) is 1.

Fig. 1. <u>Polygnathus</u> <u>bicavata</u> Ziegler. Upper view of hypotype WVGS410089, from sample 2.

2. <u>Polygnathus</u> <u>costatus</u> <u>costatus</u> Klapper. Upper view of hypotype WVGS410101, from sample 78.

3. <u>Polygnathus</u> <u>costatus</u> <u>patulus</u> Klapper. Upper view of hypotype WVGS41009[illegible], from sample [illegible]9.

4. <u>Polygnathus</u> <u>decorosus</u> Stauffer. Upper view of hypotype WVGS41[illegible]97, from sample 57.

5. <u>Polygnathus</u> <u>linguiformis</u> <u>linguiformis</u> Hinde, gamma morphotype Bultynck. Upper view of hypotype WVGS410103, from sample 78.

6. <u>Polygnathus</u> <u>webbi</u> Stauffer. Upper view of hypotype WVGS410097, from sample 39.

7. <u>Polygnathus</u> sp. A. Upper view of hypotype WVGS410096, from sample 27.

8,9. <u>Polygnathus</u> <u>nodocostatus</u> Branson & Mehl. Upper view of hypotype WVGS410095 and WVGS410104, from samples 1 and 33, respectively.

10. <u>Polylophodonta</u> aff. <u>confluens</u> (Ulrich & Bassler). Upper view of hypotype WVGS410100, from sample 2.

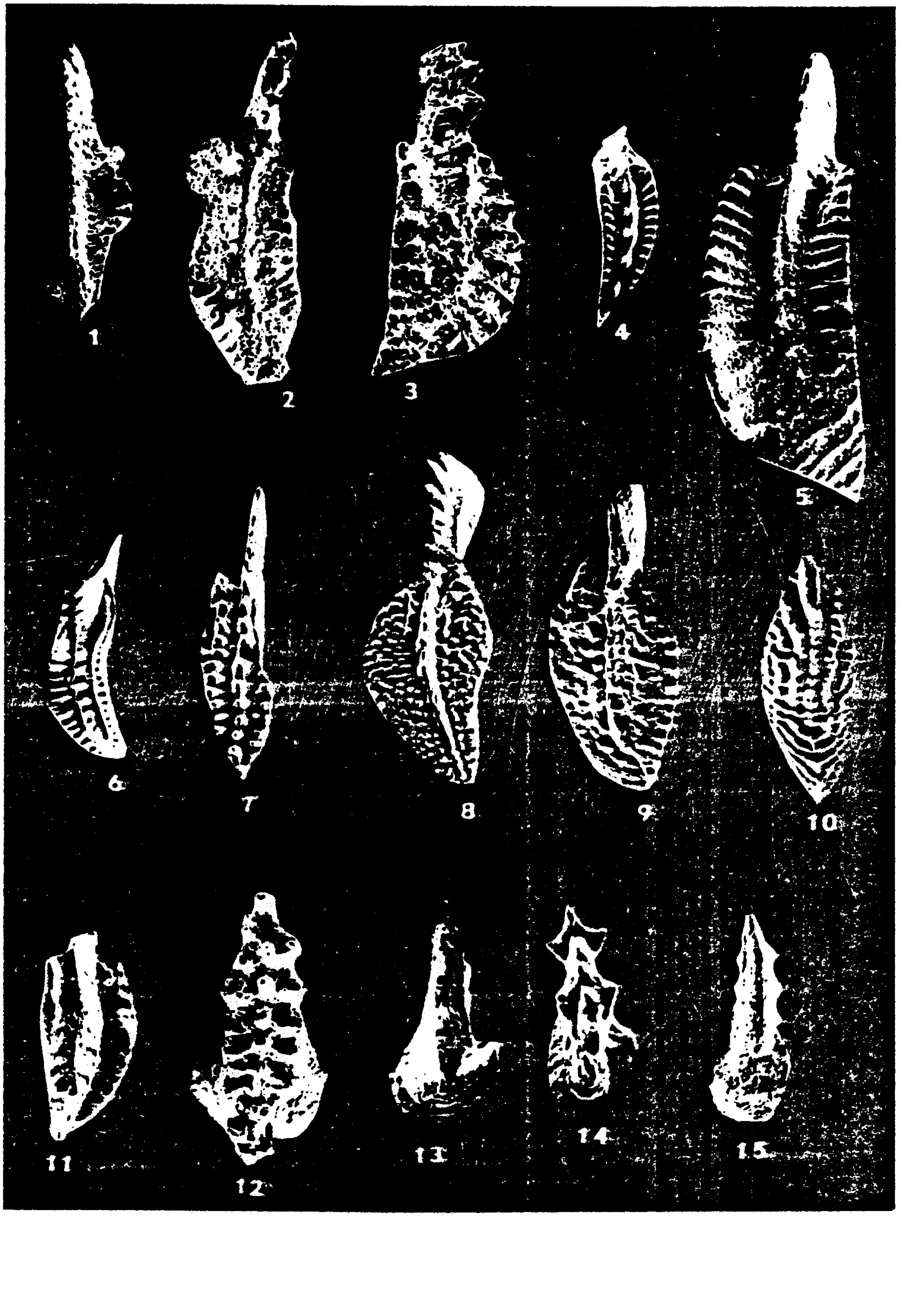
11. <u>Polygnathus</u> <u>glaber</u> <u>glaber</u> Ulrich & Bassler. Upper view of hypotype WVGS410093, from sample 33.

12, 13. <u>Icriodus</u> <u>corniger</u> Wittekindt. 12, upper view and 13, lower view of hypotype WVGS410068, from sample 81.

14. <u>Icriodus</u> <u>cornutus</u> Sannemann. Upper view of hypotype WVGS410069, from sample 22.

15. <u>Icriodus</u> <u>symmetricus</u> Branson & Mehl. Upper view of hypotype WVGS410069, from sample 65.

PLATE 1



EXPLANATION OF PLATE 4

SEM photomicrographs

Color Alteration Index (CAI) is 1.

Fig. 1. Ancryognathus asymmetricus (Ulrich & Bassler). Upper view of hypotype WVGS410102, from sample 39. X50

2. Ancryognathis cf. bifurcata (Ulrich & Bassler). Upper view of hypotype WVGS410063, from sample 35. X50

3. Ancryodella lobata [illegible] Upper view of hypotype WVGS4[illegible], from sample [illegible]

4. Ancryognathus triangularis Youngquist [illegible]r. Upper view [illegible] WV[illegible]0066, from sample 59. X100

5. Ancryodella sp. A. Upper view of hypotype WVGS410062, from sample 30. X50

6. Ancryognathus sp. A. Upper view of hypotype WVGS410065, from sample 59. X100

7. Ancryognathus sinelamina (Branson & Mehl). Upper view of hypotype WVGS410064, from sample 33. X100

8. Ancryodella curvata (Branson & Mehl). Upper view of hypotype WVGS410060, from sample 50. X50

9, 10. Scaphignathus velifer Helms. 9, upper view and 10, lateral view of hypotype WVGS410098, from sample 1. X70

11, 12. Scaphignathus velifer Helms. 11, lateral view and, 12 lower view of hypotype WVGS410099, from sample 1. X70

PLATE 4

EXPLANATION OF PLATE 5

SEM photomicrographs

Color Alteration Index (CAI) is 1.

Fig. 1. Genus indeterminant A. Upper view of hypotype WVGS410067, from sample 4. X70

2. Ozarkodina sp. A. Upper view of hypotype WVGS410071, from sample 17. X70

3. Conodont pearl, from sample 38. X100

4. Adenticulate cone ("Bellodella"), from sample 78. X100

5. Palmatolepis N-element, from sample 27. X120

6. Ozarkodina P-element from sample 34. X100

7. Ozarkodina P-element, from sample 26. X50

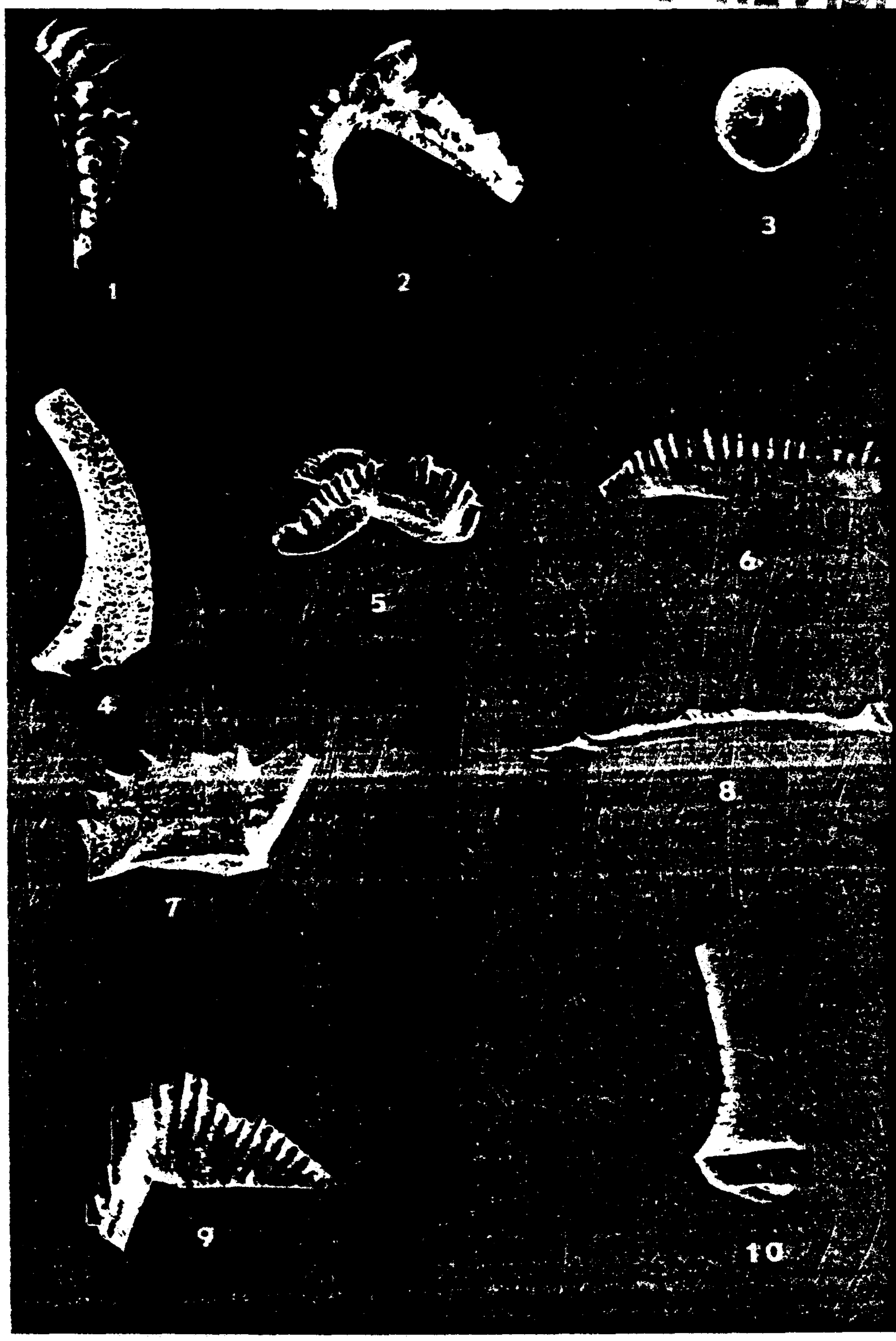
8. A1-element, from sample 17. X30

9. N-element, from sample 33. X70

10. Icriodus S1-element, from sample 44. X75.

PRELIMINARY
OPEN-FILE REPORT
SUBJECT TO REVISION

PLATE 5



VITA

Name	George R. Clarkson
Parents	Roy B. Clarkson
	G. June Clarkson
Birthplace	Morgantown, W. Va.
Date of Birth	May 22, 1956

Schools Attended

West Virginia University 1973-1976

West Virginia University 1978-1980

Degree Recieved

B.S. West Virginia University, 1976

Employment

West Virginia Geological and Economic Survey, 1976-1980

APPROVAL OF EXAMINING COMMITTEE

DATE 6/4/80

MICHAEL ED. HOHN

JOHN J. RENTON

STEVEN M. WARSHAUER
CHAIRMAN